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**DRAFT TECHNICAL MEMORANDUM
HUMAN HEALTH RISK ASSESSMENT
LANDFILL 1**

**O'HARE AIR RESERVE STATION
CHICAGO, ILLINOIS**

May 2003

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ACRONYMS AND ABBREVIATIONS

ADD	Average Daily Dose
ARS	Air Reserve Station
bgs	below ground surface
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
ELCR	Excess Lifetime Cancer Risk
EPC	Exposure Point Concentration
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IEPA	Illinois Environmental Protection Agency
LADD	Lifetime Average Daily Dose
LOAEL	Lowest Observed Adverse Effect Level
MF	Modifying Factor
NOAEL	No Observed Adverse Effect Level
POL	Petroleum, Oil and Lubricants
PRG	Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RME	Reasonable Maximum Exposure
SF	Slope Factor
SVOC	Semi-Volatile Organic Compound
UCL	Upper-bound Confidence Limit
UF	Uncertainty Factor
U.S. EPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The objective of this Human Health Risk Assessment (HHRA) is to estimate potential human health effects that could occur due to exposure to contaminants at the Landfill 1 site at and within the airfield adjacent to the Former O'Hare Air Reserve Station (ARS) in the absence of remedial measures. The HHRA was prepared in accordance with Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, Part A (USEPA, 1989a) and other supplementary USEPA guidance documents. The HHRA considers possible exposure to human populations under current and anticipated future land use scenarios, based on site and area conditions. Section 2.0 summarizes identification of contaminants of potential concern (COPC); Section 3.0 presents results of the exposure assessment; Section 4.0 discusses carcinogenic and non-carcinogenic toxicity information for COPCs; and Section 5.0 presents results of quantitative risk characterization.

1.1 BACKGROUND

Figure 1 (reproduced from the ESI) shows Landfill 1 located within the O'Hare ARS in Chicago, Illinois. Landfill 1, measuring approximately four acres, is located in the northwestern portion of O'Hare ARS and within an adjacent O'Hare International Airport airfield. Landfill 1 was used as a landfill from approximately 1953 until 1965 and is predominantly covered by native vegetation, although a portion has been covered by a runway taxiway at O'Hare Airport. An area adjacent to Landfill 1 was modified in 1991 by the addition of a new petroleum, oil and lubricants (POL) storage and pumping area. The POL area is paved and is used primarily for bulk fuel storage and transfer. Two drainage ditches traverse the area of Landfill 1.

Several investigations have been conducted to date to characterize the site. These include Site Investigation in 1986, Environmental Assessment in 1986, Stage II Site Investigation in 1988, Baseline Risk Assessment in 1990, Remedial Investigation in 1991 Expanded Site Investigation in 1996, and Boundary Delineation Study in 2001. According to past studies, the type of waste placed in the landfill is reported to include general refuse and office trash, old aircrafts parts, old kitchen-type appliances, and old tools. It is also reported that some drummed waste from the shop operations went into this landfill. The content of the drummed wastes is unknown. There was occasional burning of refuse at the landfill, but this practice reportedly ceased in 1965. Locations of the burn areas have not been identified.

1.2 RECENT SITE INVESTIGATION

The most recent site investigation is described in the Expanded Site Investigation (ESI) for Landfill 1 (Law Engineering and Environmental Services, Inc., dated January 1997). Sampling efforts for this investigation included the following:

- Advancement of 18 soil borings and the collection of soil samples at depths of 2, 4, 8, and 13 feet below ground surface (bgs).
- Two background borings drilled in areas interpreted to be unaffected by landfill operations. Two samples from each boring were collected within the depth range of suspected landfilling activity (5 to 15 feet bgs).
- Installation of 12 monitoring wells into the upper two water bearing zones beneath the site.
- Sampling of 22 monitoring wells (previously existing and newly installed wells).
- Collection of sediment and surface water samples at two locations in the drainage ditches.

A follow-on delineation study was conducted by Jacobs Engineering Group (JEG) in 2002 (JEG, March 2003). The delineation study consisted of a geophysical survey and excavation of 28 test trenches.

2.0 DATA EVALUATION AND IDENTIFICATION OF COPCS

2.1 DATA EVALUATION

The HHRA is based on the ESI data reported in Law (1997). The data, reproduced from the ESI, are presented in Appendix A. Prior to use, analytical data generated during the ESI were evaluated to determine useability in this HHRA in accordance with the Guidance for Data Useability in Risk Assessment (U.S. EPA, 1992a).

Soil, sediment, surface water, and groundwater samples were collected during the ESI. Metals, semi-volatile organic compounds (SVOCs), Aroclor 1254, and low concentrations of volatile organic compounds (VOCs) and pesticides were detected in site soils. Sediments had detectable levels of SVOCs and metals. Low concentrations of VOCs and pesticides were also detected in sediments. Groundwater contained VOCs, SVOCs, metals, and low concentrations of pesticides. Surface water contained metals and a small number of VOCs and SVOCs.

2.2 IDENTIFICATION OF COPCS

U.S. EPA Region IX Preliminary Remediation Goal (PRG) dated October 2002 for industrial land use were used as site screening levels for soil and sediment (U.S. EPA, 2002). Analytes exceeding these criteria were identified as COPCs and further evaluated in this HHRA. The combined effect of detected concentrations of individual chemicals present below their corresponding PRG value may also be of potential concern. Therefore, to screen data for possible cumulative effects, the ratios of detected concentrations to PRGs for all chemicals at each sampling location were summed. At those locations where the summed PRG ratio was found to be greater than 1, all chemicals with a PRG ratio greater than 0.1 were also identified as COPCs. An example of the comparison of detected site concentrations to PRGs is presented in Table 1. Note that the summary ratio of detected concentrations to screening values for all chemicals at sample location L-11-001SB was greater than 1 although none of the individual chemical concentration exceeds corresponding PRG.

Metals are naturally occurring elements in soil, sediment, groundwater, and surface water. Metal concentrations that do not exceed background levels are not considered in estimating carcinogenic risks and noncarcinogenic hazards. Background soil samples from four locations were collected during the ESI. Maximum detected concentrations of metals in soils and sediment were compared to the soil background levels. Data to establish background metal concentrations in groundwater and surface water at the O'Hare ARS is not available.

Based on the screening process described above, Table 2 identifies COPCs in soil at Landfill 1. Table 3 identifies COPCs in sediment. Results of the screening process for groundwater and surface water are presented in Tables 4 and 5, respectively.

3.0 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to identify human receptors that are potentially exposed to site chemicals, the manner by which an exposure occurs or is likely to occur, and the amount of the chemical intake, if any, resulting from such exposures. The exposure assessment identifies populations that are likely to be exposed to site chemicals, the various media in which chemicals are found or transported, the location where exposure occurs, and the estimated magnitude, frequency, and duration of exposure. Both current and future exposure scenarios are considered.

3.1 CHARACTERIZATION OF EXPOSURE SETTING

Biased sampling was conducted at Landfill 1 to characterize the level of contamination due to historical property use. Land use at Landfill 1 is currently industrial/commercial and will continue to be industrial/commercial following base closure. Therefore, this HHRA was conducted considering only industrial/commercial land use scenarios.

Groundwater at Landfill 1 is currently not used as a resource and there are no groundwater production wells on the property. Moreover, the potential for soil contaminants to migrate and reach groundwater is minimal. The water yielding aquifer is present at a depth of about 80 feet below the ground surface. Soils overlying this aquifer consist mostly of clay tills with permeabilities on the order of 1×10^{-9} to 1×10^{-6} cm/sec, are an estimated 80 feet in thickness, and are continuous across the site. Such soils act as an aquitard and limit infiltration of water and contaminants. Based on consideration of these factors, it was judged that the groundwater exposure pathway under the current exposure scenario is not complete for any of the receptors. Under the future exposure scenario, the use of groundwater at the ARS property is unlikely as the City of Chicago has enacted an ordinance (*Ordinance Number 097990*) that prohibits development and use of groundwater and has entered into a Memorandum of Understanding with Illinois Environmental Protection Agency (IEPA) to implement and administer this ordinance. Therefore, estimation of risks via the ingestion pathway is considered incomplete and has not been evaluated in this HHRA. However, dermal contact and inhalation of contaminants in shallow groundwater by construction workers are potentially complete pathways under the future exposure scenario.

Currently, Landfill 1 is in a secured airfield and access is restricted and controlled. The only activity occurring under current land use condition is occasional mowing of the landfill. Under the future land-use scenario, the property will continue to be commercial/industrial. However, for purposes of this risk assessment we are assuming that the Landfill 1 is not expected to be secured under the future land-use scenario and construction activities could bring subsurface soils to the surface. Therefore, exposure to soils is considered under the future land-use scenario.

There are two small ditches in the area. Under current conditions, receptors are not exposed to surface water and sediment in the ditches.

3.2 IDENTIFICATION OF POTENTIAL EXPOSURE PATHWAYS AND RECEPTORS

An exposure pathway describes the course a chemical takes from the source to the receptor and is defined by four elements: 1) A source and mechanism of release; 2) An environmental transport medium; 3) A point of potential exposure with the contaminated medium; and 4) A route of exposure at the exposure point. When all these elements are present, a pathway is considered complete. Only complete exposure pathways are selected for evaluation in a risk assessment.

A conceptual site model (CSM) has been developed to aid in identification of potential exposure pathways and receptors at the Landfill 1 (Figure 2). Contaminants in the landfill soil can either remain in soil or are transferred through secondary release mechanisms to groundwater, air, and surface water/sediment. Based on this CSM, principal exposure pathways by which current and potential future receptors may be exposed are ingestion, inhalation, or dermal contact with soil, dermal contact with groundwater, surface water and sediment, and inhalation of fugitive emissions.

The mower is defined as a worker that mows the landfill three days per year. Exposure to soil and particulates in air is considered in this HHRA for the current land-use scenario.

The on-site worker is defined as a worker who under the future land-use scenario works inside a building or other industrial/commercial facilities. Activities of such workers are limited to indoor areas of the proposed or existing facilities and parking lots. Exposure to soil and contaminants attached to particulates in air are complete under future land-use scenario.

Maintenance workers are defined as workers who will occasionally conduct repair or maintenance work in connection with utility systems and also workers that prepare and maintain landscapes. Exposure to soil, particulates in air, sediment, and surface water by maintenance workers are considered in this HHRA for both current and future land-use scenarios.

Trespassers to the site include visitors and those entering the site for recreational purposes. As the Landfill 1 is a secured airfield, trespassers currently are not allowed to enter the property. However, under the future land-use scenario, it is assumed that visitors/trespassers can freely enter the site without any restrictions and could potentially be exposed to soil and particulates in air. A trespasser is not expected to use or be exposed to contaminants in the small ditches.

Construction activities are not currently being conducted at the base. However, under the future land-use scenario, construction of buildings, roads, and other structures is anticipated. Therefore, construction workers may be exposed to contaminants in soil, particulates in air, sediment, surface water, and groundwater under the future land-use scenario.

In summary, the current and/or potential future exposure pathways included in this HHRA are:

- Ingestion, inhalation, and dermal contact with soils by current mowers.
- Ingestion, inhalation, and dermal contact with soils by future on-site workers.
- Ingestion, inhalation, and dermal contact with soils and dermal contact with sediment and surface water by future maintenance workers.
- Ingestion, inhalation, and dermal contact with soils, dermal contact with sediment and surface water, and inhalation and dermal contact with groundwater by future construction workers.
- Ingestion, inhalation, and dermal contact with soils by future trespassers

3.3 ESTIMATION OF EXPOSURE POINT CONCENTRATIONS

The Exposure Point Concentration (EPC) is defined as the concentration of a COPC that a human receptor can potentially come in contact with. EPCs were calculated using procedures described in Supplemental Guidance to RAGS: Calculating the Concentration Term (U.S. EPA, 1992b). EPCs are estimates of the arithmetic average concentration of a contaminant in a specific media. Due to uncertainties associated with estimating the true average concentration, the 95 percent upperbound confidence limit (UCL) of the arithmetic mean concentration is used as a measure of the arithmetic average concentration.

The type of distribution of the data set was first determined because equations used to calculate EPCs vary for normal and lognormal distributions. The Shapiro and Wilk's W-Test (Gilbert, 1987) was used to determine the distribution of the data sets. In all exposure areas and for all COPCs, the data sets were found to be distributed neither normally nor lognormally. Therefore, in accordance with U.S. EPA guidance (U.S. EPA, 1992b), lognormal distribution was assumed as a default distribution. Data sets with less than three samples in a particular exposure area containing detected values for a specific COPC were not tested and were assumed to be distributed lognormally.

Proxy values were assigned to non-detect samples. Although a chemical may be reported as non-detect, it may be present at a concentration below the quantitation limit. As a conservative measure, one half the value of the sample quantitation limit was used as a proxy value for non-detected samples.

EPCs were then calculated using equations presented in U.S. EPA guidance (1992b) for determining 95 percent UCL under normal or lognormal distribution. Where the calculated 95 percent UCL value was higher than the maximum value in the data set, the maximum value was selected as the EPC. EPCs were calculated for soil, sediment, surface water, and groundwater. Calculated EPCs are listed in Appendix B.

- Receptors could potentially be exposed to fugitive emissions from soil. Concentration of COPCs sorbed onto particulates in air were estimated based on soil analytical data using procedures presented in (USEPA, 1989b). Calculated air concentrations of COPCs are presented in Appendix B.

3.4 QUANTIFICATION OF EXPOSURE

Exposure dose equations consider contact rate, receptor body weight, and frequency and duration of exposure. All exposures quantified in this HHRA are normalized for time and body weight and are presented in units of milligram (mg) per kilogram (kg) of body weight per day. A lifetime average daily dose (LADD) and an average daily dose (ADD) were calculated to estimate carcinogenic risks and noncarcinogenic hazards, respectively.

Equations to calculate ADD and LADD via ingestion of soil are,

$$\text{ADD (mg/kg-day)} = \text{EPC} \times \text{FI} \times \text{IRS} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{ATn}) \quad (1)$$

$$\text{LADD (mg/kg-day)} = \text{EPC} \times \text{FI} \times \text{IRS} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{ATc}) \quad (2)$$

where:

EPC, mg/kg = Exposure Point Concentration
FI, unitless = Fraction Ingested from Contaminated Source
IRS, mg/day = Soil Ingestion Rate
EF, days/year = Exposure Frequency
ED, years = Exposure Duration
CF, 10^{-6} kg/mg = Conversion Factor
BW, kg = Body Weight
ATn, days = Averaging Time for Noncarcinogens
ATc, days = Averaging Time for Carcinogens

Equations to calculate ADD and LADD via inhalation of particulates are,

$$\text{ADD (mg/kg-day)} = \text{EPCp} \times \text{IR} \times \text{ER} \times \text{EF} \times \text{ED} / (\text{BW} \times \text{ATn}) \quad (3)$$

$$\text{LADD (mg/kg-day)} = \text{EPCp} \times \text{IR} \times \text{ER} \times \text{EF} \times \text{ED} / (\text{BW} \times \text{ATc}) \quad (4)$$

where:

EPCp, mg/m³ = Exposure Point Concentration of particulates in air

IR, m³/hr = Inhalation Rate

ER, hrs/day = Exposure Rate

Equations to calculate ADD and LADD via dermal contact with soils and sediments are;

$$\text{ADD (mg/kg-day)} = \text{EPC} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{ATn}) \quad (5)$$

$$\text{LADD (mg/kg-day)} = \text{EPC} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{ATc}) \quad (6)$$

where:

SA, cm² = Body Surface Area

AF, mg/cm² = Soil Adherence Factor

ABS, unitless = Dermal Adsorption Factor

Equations to calculate ADD and LADD via dermal contact with groundwater and surface water are;

$$\text{ADD (mg/kg-day)} = \text{EPC} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{ATn}) \quad (7)$$

$$\text{LADD (mg/kg-day)} = \text{EPC} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF} / (\text{BW} \times \text{ATc}) \quad (8)$$

where:

PC, cm/hour = Permeability Constant

ET, hours/day = Exposure Time

Equations to calculate ADD and LADD via inhalation of volatiles from groundwater are;

$$\text{ADD (mg/kg-day)} = \text{EPCa} \times \text{IR} \times \text{EF} \times \text{ED} / (\text{BW} \times \text{ATn} \times \text{CF}) \quad (9)$$

$$\text{LADD (mg/kg-day)} = \text{EPCa} \times \text{IR} \times \text{EF} \times \text{ED} / (\text{BW} \times \text{ATc} \times \text{CF}) \quad (10)$$

where:

EPCa, mg/m^3 = Exposure Point Concentration in air.

EPCa was calculated using a "box model" approach as described in U.S. EPA (1986). This approach is described in Appendix C - Air Concentration Model for Groundwater Volatile COPCs.

3.5 EXPOSURE FACTORS

Values for exposure factors are required as input parameters in equations (1) through (10), presented in Section 3.5. Parameter values via ingestion, inhalation, dermal contact with soil, dermal contact with sediment and surface water, and inhalation and dermal contact with groundwater pathways are presented in Table 6. The dermal absorption factors for use in Equations (5), and (6), and the permeability constants for use in Equations (7) and (8) are listed in Table 7.

Exposure factors were obtained from guidance documents such as the Exposure Factors Handbook (U.S. EPA, 1995), Superfund's Standard Default Exposure factors for the Central Tendency and Reasonable Maximum Exposure (U.S. EPA, 1993), and reasonable conservative assumptions regarding types of activities and nature of exposure.

4.0 TOXICITY ASSESSMENT

The purpose of toxicity assessment is to compile toxicity and carcinogenicity data for the COPCs and to provide quantitative indices of toxicity necessary to calculate potential risk in the risk characterization. Chemicals are classified as potential carcinogens or noncarcinogens because the dose-response relationships for carcinogenic and noncarcinogenic effects are different and require different assessment approaches. The dose-relationship between noncarcinogenic effect generally exhibits a threshold dose below which no adverse effects occur. No threshold doses have been shown to exist for most carcinogenic effects.

4.1 HEALTH EFFECTS CRITERIA AND ASSESSMENT, CARCINOGENS

U.S. EPA's Carcinogenic Assessment Group has estimated the excess lifetime cancer risks associated with various levels of exposure to potential human carcinogens by developing cancer slope factors (SFs). The SFs are generally derived using conservative (health protective) assumptions. Cancer SFs developed by U.S. EPA were used in this risk assessment. The toxicity values for potential carcinogenic effects of the COPCs are listed in Table 7.

U.S. EPA has developed weight-of-evidence classifications for potential carcinogens. The weight-of-evidence classification is an attempt to determine the likelihood that an agent is a human carcinogen; the classification thus affects the likelihood that an agent will induce cancer in humans but it does not impact numerical potency or the estimation of risk. The classification of carcinogenicity relies on the overall evidence as follows:

- Human carcinogens (Group A chemicals) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.
- Probable Human carcinogens (Group B1 and B2) are agents for which there is limited (B1) or inadequate (B2) evidence of carcinogenicity from human studies. Group B2 chemicals also may be agents which have sufficient evidence of carcinogenicity from animal studies.
- Possible human carcinogens (Group C) are agents for which there is limited evidence of carcinogenicity in animals.
- Not classified as human carcinogens (Group D) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.
- Nonhuman carcinogens (Group E) are agents for which there is no evidence of carcinogenicity in adequate human or animal studies.

According to this classification scheme, arsenic and benzene are classified as Group A carcinogens, cadmium is classified as a B1 carcinogen, and polyaromatic hydrocarbons (PAH) are considered group B2 carcinogens. The target organ or system for each carcinogenic COPC is listed in Table 7.

4.2 HEALTH EFFECTS CRITERIA AND ASSESSMENT, NONCARCINOGENS

Health effects for chemicals exhibiting noncarcinogenic effects are generally developed using reference doses (RfDs). The RfD is an estimate of the daily exposure to the human population that is likely to be without an appreciable risk during a lifetime. The uncertainty associated with the RfD is at least one order of magnitude and may be as high as several orders of magnitude. RfDs are expressed in units of dose (mg/kg-day) and are developed by USEPA. Table 7 lists the RfDs for potential noncarcinogenic effects for the COPCs.

The RfDs are selected by identifying the lowest reliable no observed effect level (NOAEL) or lowest observed adverse effect level (LOAEL) in the scientific literature, then applying a suitable uncertainty factor (UF) and a modifying factor (MF), to allow for differences between the study conditions and the human exposure situation to which the RfDs are to be applied.

Each COPC exerts noncarcinogenic effects on specific target organs or mode of action. For example, pyrene is known to affect kidneys while barium affects the circulatory or reproductive systems. In evaluating health effects due to exposure to multiple COPCs, consideration is given to the COPCs with similar target organ effects. The target organ or system of each non-carcinogenic COPC is listed in Table 7.

5.0 RISK CHARACTERIZATION

Carcinogenic risks and noncarcinogenic hazards were characterized for each chemical, multiple chemicals within each exposure pathway, and for exposures attributable to multiple pathways, as appropriate.

5.1 CARCINOGENIC RISKS

Quantitative human risk estimates were derived by combining the estimates of chemical intake derived in the Exposure Assessment with the health effects criteria presented in the Toxicity Assessment. For potential carcinogenic chemicals, excess lifetime cancer risks (ELCR) are estimated by multiplying the cancer slope factor by the estimated daily chemical intake. The estimated ELCR represents a high-end probability that an individual could contract cancer due to exposure to the potential carcinogen under the specified exposure conditions.

ELCRs are calculated using equation (11):

$$\text{ELCR} = \text{LADD} \times \text{SF} \quad (11)$$

The intake is assumed to occur by inhalation, ingestion, and dermal contact. Therefore, additivity of effects is assumed such that the total ELCR for each chemical is obtained by summing the chemical specific risk estimated for both pathways as it relates to a specific medium. The total ELCR for exposure to multiple chemicals is expressed as:

$$\text{ELCR}_e = \text{ELCR}_1 + \text{ELCR}_2 + \text{ELCR}_3 + \dots + \text{ELCR}_i \quad (12)$$

where:

ELCR_e = Total exposure via a specific pathway
 ELCR_i = ELCR estimate for the i th chemical

The total ELCR equals risks via all appropriate pathways, and is expressed as:

$$\text{Total ELCR} = \text{ELCR}_{e1} + \text{ELCR}_{e2} + \dots + \text{ELCR}_{ei} \quad (13)$$

where:

ELCR_{ei} = ELCR resulting from the i th pathway.

Carcinogenic risks are expressed as a probability for a receptor to develop cancer. A risk level of 1×10^{-6} (or 1E-06) represents a high-end probability of 1 in 1,000,000. U.S. EPA

generally uses a potential upper-bound risk estimate of 1E-06 as a point of departure, while a risk range of 1E-04 to 1E-06 is used as a target range for making risk management decisions. U.S. EPA (1991) states that the upper boundary of the risk range is not a discrete line at 1E-04. A specific risk estimate around 1E-04 may be acceptable at some sites.

5.2 NONCARCINOGENIC RISKS

Noncarcinogenic hazards are presented as the ratio of the daily intake to the RfD or Hazard Quotient (HQ). The HQ for a specific chemical is calculated by:

$$HQ = ADD/RfD \quad (14)$$

Chemicals that cause noncarcinogenic hazards target specific organs within a human. Noncarcinogenic hazard attributable to exposure to all chemicals that affect the same organ via a specific exposure pathway is expressed as hazard index (HI) as follows:

$$HI_e = HQ_1 + HQ_2 + \dots + HQ_i \quad (15)$$

where:

HI_e = hazard index via a specific pathway
 HQ_i = hazard quotient for the i th chemical

The total noncarcinogenic hazard is calculated by:

$$\text{Total HI} = HI_{e1} + HI_{e2} + \dots + HI_{ei} \quad (16)$$

where:

HI_{ei} = hazard index via the i th pathway

The HI is useful as a reference point for gauging the potential effects of the environmental exposures to complex mixtures. A HI greater than one suggests that human health effects would be possible if exposure occurred under the conditions evaluated in the assessment. In general, a HI less than one is unlikely to be associated with any health risks. In this HHRA, HIs for all pathways and COPCs were summed to generate cumulative HI values. Effects of COPCs that impact specific target organs were not considered in this risk assessment.

5.3 RISK CHARACTERIZATION

Potential carcinogenic risks and noncarcinogenic hazards are estimated for each medium under exposure scenarios characterized in the CSM and under the assumptions used in calculating the daily doses. Under the current land use scenario, the only receptors are mowers. Under the future land-use scenario, receptors are on-site workers, maintenance workers, construction workers, and trespassers. The exposure media is surface soil under current land-use scenario and soil, groundwater, sediment, and surface water under future land-use scenario. Carcinogenic and noncarcinogenic risks were calculated via ingestion, inhalation, and dermal contact pathways. Calculation of ADD, LADD, HI, and ELCR for each exposure area is presented in Appendix D. Estimated risks from exposure to all media are summarized in Table 8.

Soil

Total HIs for all receptors were found to be less than 1. Carcinogenic risks were less than $1\text{E-}06$. This implies that noncarcinogenic and carcinogenic hazards due to soil exposure at Landfill 1 are not likely to be significant.

Sediment

Carcinogenic risks were less than $1\text{E-}06$ for all receptors. This implies that carcinogenic hazards due to sediment exposure at Landfill 1 are not likely to be significant. Constituents that cause noncarcinogenic hazards were not identified in sediment.

Surface Water

Total HIs for all receptors were found to be less than 1. Carcinogenic risks were less than $1\text{E-}06$ for all receptors. This implies that noncarcinogenic and carcinogenic hazards due to surface water exposure at Landfill 1 are not likely to be significant.

Groundwater

Total HIs for all receptors were found to be less than 1. This implies that noncarcinogenic hazards due to groundwater exposure at Landfill 1 are not likely to be significant. Carcinogenic risks were less than $1\text{E-}06$ for all receptors.

Total risks from exposure to contaminants in soil, sediment, surface water, and groundwater for all receptors are also presented in Table 8. Carcinogenic risks for all receptors are less than $1\text{E-}06$. Noncarcinogenic hazards for all receptors are less than 1.

6.0 UNCERTAINTY ASSESSMENT

Uncertainties are introduced at various points throughout the risk assessment process, a product of the uncertainties associated with all data and the assumptions used. Specific uncertainties are related to data evaluation, exposure assessment, toxicity assessment, and risk characterization are discussed in this section.

6.1 EXPOSURE ASSESSMENT

The exposure estimates used in this HHRA are conservative and, to be protective of health, are designed to overestimate actual risks when there is an uncertainty. Several of the factors contributing to uncertainty result in probable overestimation of exposure:

- The directed (biased) nature of much of the sampling strategy (i.e. focusing on the most contaminated parts of the site);
- The use of the upper bound of 95% UCL values and maximum concentrations as EPCs in the exposure estimation;
- The use of steady state assumptions for the source concentration estimates (i.e. the COPC concentrations are not subject to decrease due to attenuation and/or degradation for the duration of the exposure period); and
- The use of conservative assumptions on exposure frequency and exposure duration for workers and trespassers;

A factor which could lead to over or underestimation of exposures is:

- The use of one-half MDL to estimate the non-detects.

6.2 TOXICITY ASSESSMENT

Basic uncertainties underlying the assessment of the toxicity of a chemical include:

- Uncertainties arising from the design, execution, or relevance of the scientific studies that form the basis of U.S. EPA's risk assessment; and
- Toxicity factors are not available for some chemicals. Elimination of such chemicals from consideration as COPCs results in underestimation of risks.

- Uncertainties involved in extrapolating from underlying scientific studies to the exposure scenarios being evaluated, including variable responses to chemical exposures in human and species and between species.

These basic uncertainties could either under or overestimate the true toxicity of chemicals present. U.S. EPA's toxicity assessment process compensates for these uncertainties through the use of uncertainty factors and modifying factors when deriving RfDs for noncarcinogens, and the use of 95 percent confidence limit when deriving the SFs for carcinogens.

6.3 RISK CHARACTERIZATION

Uncertainties associated with the overall risk assessment, the cumulative effect of conservative assumptions throughout the process and the likelihood of the exposures postulated and estimated in the exposure assessment actually occurring are:

- The cumulative effect of conservative assumptions throughout the risk assessment may substantially overestimate the true risks. U.S. EPA guidance recommends that individual exposure parameters be selected so that the resulting overall estimates of exposure represents a reasonable maximum exposure condition (RME). However, in many cases, the actual statistical distribution of a parameter is unknown (i.e., the amount of soil ingested). When there is a doubt, U.S. EPA has erred in favor of protecting human health, and selected an RME default value that result in overestimating the risks. Therefore, the nature of risk estimation process ensures that the true risks are more likely to be overestimated than underestimated.
- The exposure pathways identified are plausible and exposure may be expected to occur. However, postulated frequencies of occurrence for all exposure scenarios were chosen to overestimate routine occurrence but more likely reflect an upper bound frequency of occurrence. For example, it is assumed that on-site workers will be exposed at the rate of 52 days per year for 25 years. The reality is that they more likely stay indoors, do not come in contact with contaminated soil, and have a tenure at the facility much less than 25 years.

7.0 SUMMARY OF HUMAN HEALTH RISK ASSESSMENT

This HHRA was conducted to assess the potential adverse human health effects that could occur due to exposure to contaminants present at Landfill 1, O'Hare ARS, in the event no action is taken to remove contaminants and/or prevents their migration. The assessment was prepared in accordance with the RAGS (U.S. EPA, 1989a).

Noncarcinogenic hazards were found to be not significant for any of the receptors, as is indicated by HI values of less than one.

Carcinogenic hazards were found to be not significant for any of the receptors, as is indicated by ELCR values not greater than 1E-06.

8.0 REFERENCES

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Table 1
Comparison of Detected Concentrations to PRGs
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Location: L-11-001SB

Analyte Name	Unit	PRG	Concentration	HQ	HQ>0.1
Metals					
Aluminum	mg/kg	100000	9430	0.094	
Cadmium	mg/kg	7.4	7	0.946	Yes
Barium	mg/kg	67000	132	0.002	
Chromium	mg/kg	450	32.1	0.071	
Cobalt	mg/kg	1900	11.6	0.006	
Copper	mg/kg	41000	134	0.003	
Manganese	mg/kg	19000	704	0.037	
Nickel	mg/kg	20000	54.8	0.003	
Thallium	mg/kg	67	0.47	0.007	
Vanadium	mg/kg	7200	27	0.004	
Zinc	mg/kg	100000	323	0.003	
SVOCs					
Benzo(a)anthracene	µg/kg	2100	17	0.008	
Benzo(b)fluoranthene	µg/kg	2100	52	0.025	
Bis(2-ethylhexyl)phthalate	µg/kg	120000	35	0.000	
Fluoranthene	µg/kg	22000000	100	0.000	
Pyrene	µg/kg	29000000	87	0.000	
VOCs					
Acetone	µg/kg	6000000	26	0.000	
Carbon Disulfide	µg/kg	720000	1	0.000	
Methylene Chloride	µg/kg	21000	1	0.000	
PCBs					
Aroclor 1254	µg/kg	740	140	0.189	Yes

HQ Summary	1.399
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Table 2
Soil Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Industrial Soil)	Background	COPC
Metals					
Aluminum	mg/kg	10900	100000	10500	
Antimony	mg/kg	4.4	410	0.06	
Arsenic	mg/kg	9.3	1.6	9.8	
Barium	mg/kg	132	67000	120	
Beryllium	mg/kg	0.59	1900	0.55	
Cadmium (a)	mg/kg	7	7.4	3.8	COPC
Calcium	mg/kg	112000	NV	153000	
Chromium, Total	mg/kg	68.3	450	18.4	
Cobalt	mg/kg	35.6	1900	12.6	
Copper	mg/kg	2100	41000	28	
Iron	mg/kg	38200	NV	22500	
Lead	mg/kg	231	750	27.2	
Magnesium	mg/kg	60300	NV	30400	
Manganese	mg/kg	1100	19000	1490	
Mercury	mg/kg	0.09	62	0.09	
Nickel	mg/kg	69.2	20000	39.7	
Potassium	mg/kg	2330	NV	2070	
Selenium	mg/kg	0.4	51000	0.3	
Sodium	mg/kg	218	NV	185	
Thallium	mg/kg	0.92	67	0.59	
Vanadium	mg/kg	29.3	7200	28.2	
Zinc	mg/kg	1380	100000	58.4	
VOCs					
Acetone	µg/kg	59	6000000	NV	
Benzene	µg/kg	3	1300	NV	
Carbon Disulfide	µg/kg	7	720000	NV	
Hexane	µg/kg	9	110000	NV	
Methylene Chloride	µg/kg	16	21000	NV	
Toluene	µg/kg	3	520000	NV	
Pesticides/PCBs					
4,4'-DDD	µg/kg	25	10000	NV	
4,4'-DDE	µg/kg	2.5	7000	NV	
4,4'-DDT	µg/kg	2.3	7000	NV	
Dieldrin	µg/kg	1	110	NV	
Endosulfan I (b)	µg/kg	0.56	3700000	NV	
Endosulfan II (b)	µg/kg	7.3	3700000	NV	
Endrin	µg/kg	0.88	180000	NV	
Endrin Ketone	µg/kg	83	NV	NV	
gamma-Chlorodane (c)	µg/kg	1.9	6500	NV	
Heptachlor	µg/kg	0.47	380	NV	
Methoxychlor	µg/kg	1.3	3100000	NV	
Aroclor 1254 (a)	µg/kg	140	740	NV	COPC
Semivolatile Organic Compounds					
Acenaphthene	µg/kg		29000000	NV	

Table 2
Soil Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Industrial Soil)	Background	COPC
Anthracene	µg/kg	39	100000000	NV	
Benzo(a)anthracene	µg/kg	150	2100	NV	
Benzo(a)pyrene	µg/kg	150	210	NV	
Benzo(b)fluoranthene	µg/kg	290	2100	NV	
Benzo(g,h,i)perylene	µg/kg	19	NV	NV	
Bis(2-ethylhexyl)phthalate	µg/kg	630	120000	NV	
Chrysene	µg/kg	180	210000	NV	
Di-n-butylphthalate	µg/kg	5	62000000	NV	
Di-n-octylphthalate	µg/kg	79	25000000	NV	
Fluoranthene	µg/kg	410	22000000	NV	
Indeno(1,2,3-cd)pyrene	µg/kg	50	2100	NV	
Phenanthrene	µg/kg	230	NV	NV	
Pyrene	µg/kg	320	29000000	NV	

Constituents for which the maximum detected concentration is above the Region 9 PRGs for industrial soil and background for soil were identified as COPCs.

COPC Chemical of potential concern

NV No value available

a) The summary ratio of detected concentrations to screening values for all chemicals at sample location L-11-001SB is greater than 1. Among all the chemicals, cadmium and Aroclor have a concentration/screening value ratio greater than 0.1. Therefore, cadmium and Aroclor 1254 were considered as COPCs.

b) Screening value for Endosulfan (total) is 3700000 µg/kg

c) Screening value for Chlorodane (total) is 6500 µg/kg

Table 3
Sediment Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Industrial Soil)	Background	COPC
Metals					
Aluminum	mg/kg	6210	100000	10500	
Antimony	mg/kg	14.7	410	0.06	
Arsenic	mg/kg	5	1.6	9.8	
Barium	mg/kg	100	67000	120	
Beryllium	mg/kg	0.95	1900	0.55	
Calcium	mg/kg	42800	NV	153000	
Chromium, Total	mg/kg	12.5	450	18.4	
Cobalt	mg/kg	9	1900	12.6	
Copper	mg/kg	30.4	41000	28	
Iron	mg/kg	13700	NV	22500	
Lead	mg/kg	28	750	27.2	
Magnesium	mg/kg	19700	NV	30400	
Manganese	mg/kg	309	19000	1490	
Nickel	mg/kg	18.8	20000	39.7	
Potassium	mg/kg	965	NV	2070	
Selenium	mg/kg	0.19	51000	0.3	
Sodium	mg/kg	353	NV	185	
Thallium	mg/kg	0.26	67	0.59	
Vanadium	mg/kg	11.9	7200	28.2	
Zinc	mg/kg	194	100000	58.4	
VOCs					
Acetone	µg/kg	110	6000000	NV	
2-Butanone	µg/kg	21	NV	NV	
1,2-Dichloroethene, total (a)	µg/kg	8	150000	NV	
Trichloroethene	µg/kg	1	110	NV	
Pesticides					
4,4'-DDE	µg/kg	1.2	7000	NV	
4,4'-DDT	µg/kg	3.1	7000	NV	
Dieldrin	µg/kg	1.1	110	NV	
Endrin	µg/kg	1.3	180000	NV	
Semivolatile Organic Compounds (b)					
Acenaphthene	µg/kg	120	29000000	NV	
Anthracene	µg/kg	330	100000000	NV	
Benzo(a)anthracene	µg/kg	1600	2100	NV	COPC
Benzo(a)pyrene	µg/kg	2000	210	NV	COPC
Benzo(b)fluoranthene	µg/kg	3200	2100	NV	COPC
Benzo(g,h,i)perylene	µg/kg	1600	NV	NV	
Benzo(k)fluoranthene	µg/kg	1000	2100	NV	COPC
Bis(2-ethylhexyl)phthalate	µg/kg	490	120000	NV	
Butylbenzylphthalate	µg/kg	39	100000000	NV	
Chrysene	µg/kg	2400	210000	NV	COPC

Table 3
Sediment Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Industrial Soil)	Background	COPC
Dibenz(a,h)anthracene	µg/kg	330	210	NV	COPC
Dibenzofuran	µg/kg	99	3100000	NV	
Diethylphalate	µg/kg	8	100000000	NV	
Di-n-butylphalate	µg/kg	23	62000000	NV	
Fluoranthene	µg/kg	4000	22000000	NV	
Fluorene	µg/kg	200	26000000	NV	
Indeno(1,2,3-cd)pyrene	µg/kg	1700	2100	NV	COPC
Napthalene	µg/kg	40	190000	NV	
2-methylnaphalene	µg/kg	30	NV	NV	
Phenanthrene	µg/kg	1500	NV	NV	
Phenol	µg/kg	11	100000000	NV	
Pyrene	µg/kg	4300	29000000	NV	

Constituents for which the maximum detected concentration is above the Region 9 PRGs for industrial soil and background for soil were identified as COPCs.

COPC Chemical of potential concern

NV No value available

a) Use PRG of 1,2-Dichloroethene (cis-) as a surragant value.

b) All the carcinogenic PAHs were selected as COPCs if the maximum concentration of at least one carcinogenic PAH exceeded the screening value. The carcinogenic PAHs include: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene and Indeno(1,2,3-cd)pyrene.

Table 4
Groundwater Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Tap Water)	COPC
Metals				
Aluminum	mg/L	35.5	36	
Arsenic	mg/L	0.0129	0.000045	COPC
Barium	mg/L	0.527	2.6	
Cadmium	mg/L	0.0054	0.018	
Calcium	mg/L	275	NV	
Chromium, Total	mg/L	0.372	NV	
Cobalt	mg/L	0.0298	0.73	
Copper	mg/L	0.102	1.5	
Iron (a)	mg/L	73.7	11	
Lead	mg/L	0.208	NV	
Magnesium	mg/L	175	NV	
Manganese	mg/L	1.89	0.88	COPC
Nickel	mg/L	0.108	0.73	
Potassium	mg/L	444	NV	
Selenium	mg/L	0.0027	0.18	
Sodium	mg/L	163	NV	
Thallium	mg/L	0.0012	0.0024	
Vanadium	mg/L	0.0902	0.26	
Zinc	mg/L	0.42	11	
VOCs				
Benzene	µg/L	9	0.34	COPC
Carbon Disulfide	µg/L	0.9	1000	
Ethylbenzene	µg/L	5	2.9	COPC
Methylene Chloride	µg/L	7	4.3	COPC
Toluene	µg/L	2	720	
Xylene (Total)	µg/L	9	210	
Pesticides				
4,4'-DDD	µg/L	0.0074	0.28	
Endrin	µg/L	0.022	11	
Endrin Ketone	µg/L	0.024	NV	
Methoxychlor	µg/L	0.052	180	
Semivolatile Organic Compounds				
Acenaphthene	µg/L	78	370	
Anthracene	µg/L	32	1800	
Benzo(a)anthracene	µg/L	15	0.092	COPC
Benzo(a)pyrene	µg/L	9	0.0092	COPC
Benzo(b)fluoranthene	µg/L	15	0.092	COPC
Benzo(g,h,i)perylene	µg/L	0.2	NV	
Benzo(k)fluoranthene	µg/L	4	0.92	COPC
Bis(2-ethylhexyl)phthalate	µg/L	0.8	4.8	
Chrysene	µg/L	15	9.2	COPC
Dibenzofuran	µg/L	41	24	COPC
Diethylphthalate	µg/L	2	29000	

Table 4
Groundwater Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Tap Water)	COPC
Di-n-butylphalate	µg/L	0.1	3600	
Fluoranthene	µg/L	80	1500	
Fluorene	µg/L	63	240	
Indeno(1,2,3-cd)pyrene	µg/L	1	0.092	COPC
Napthalene	µg/L	120	6.2	COPC
2-methylnaphalene	µg/L	18	NV	
Phenanthrene	µg/L	160	NV	
Phenol	µg/L	2	22000	
Pyrene	µg/L	51	180	

Constituents for which the maximum detected concentration is above the Region 9 PRGs for tap water were identified as COPCs.

COPC Chemical of potential concern

NV No value available

a) Iron is an essential nutrient, which is not considered as a COPC.

Table 5
Surface Water Contaminants of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Region IX PRGs (Tap Water)	COPC
Metals				
Aluminum	mg/L	1.02	36	
Arsenic	mg/L	0.001	0.000045	COPC
Barium	mg/L	0.0506	2.6	
Cadmium	mg/L	0.0044	0.018	
Calcium	mg/L	119	NV	
Chromium, Total	mg/L	0.0174	NV	
Copper	mg/L	0.0382	1.5	
Iron	mg/L	1.49	11	
Lead	mg/L	0.0021	NV	
Magnesium	mg/L	53.2	NV	
Manganese	mg/L	0.214	0.88	
Potassium	mg/L	3.96	NV	
Sodium	mg/L	22.2	NV	
Zinc	mg/L	0.0852	11	
VOCs				
1,2-Dichloroethene (Total)	µg/L	4	61	
Toluene	µg/L	0.6	720	
Trichloroethene	µg/L	1	0.028	COPC
Semivolatile Organic Compounds				
Bis(2-ethylhexyl)phthalate	µg/L	2	4.8	
Di-n-butylphalate	µg/L	0.2	3600	

Constituents for which the maximum detected concentration is above the Region 9 PRGs for tap water were identified as COPCs.

COPC Chemical of potential concern

NV No value available

Table 6
Exposure Parameters
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Parameter	Units	Mower	Maintenance Workers	On-Site Workers	Construction Workers	Trespasser
General						
Exposure Frequency (EF)	days/year	3 a	250	52 b	30	52 c
Exposure Duration (ED)	years	25	25	25	1	11 c
Body Weight (BW)	kg	70	70	70	70	44 d
Averaging Time-noncarcinogenic effects (AT-n) ^(e)	days	9125	9125	9125	40	4015
Averaging Time-carcinogenic effects (AT-c)	days	25550	25550	25550	25550	25550
Ingestion of Soil						
Ingestion Rate (IRs)	mg soil/day	100	100	100	480	100
Fraction Ingested (FI) ^(f)	unitless	0.25	0.5	0.25	1	0.25
Conversion Factor (CF)	kg/mg	1.0E-06	0.000001	1.0E-06	0.000001	1.0E-06
Dermal Contact With Soil						
Conversion Factor (CF)	kg/mg	1.0E-06	0.000001	1.0E-06	0.000001	1.0E-06
Surface Area (SA) ^(g)	cm ²	5300	5300	5300	5300	4400
Soil Adherence Factor (AF _{so})	mg/cm ² -day	0.2 h	0.2 h	0.11 g	0.5 h	0.11 g
Dermal Absorption Factor (ABS)	unitless	-----Chemical specific - See Table 7-----				
Dermal Contact With Sediment						
Exposure Frequency (EF) ^(f)	days/year	--	5	--	5	--
Conversion Factor (CF)	kg/mg	--	0.000001	--	0.000001	--
Surface Area (SA) ⁽ⁱ⁾	cm ²	--	3300	--	3300	--
Sediment Adherence Factor (AF _{se}) ^(j)	mg/cm ² -day	--	0.2	--	0.5	--
Dermal Absorption Factor (ABS)	unitless	-----Chemical specific - See Table 7-----				
Dermal Contact with Surface Water						
Exposure Frequency (EF) ^(f)	days/year	--	5	--	5	--
Exposure Time (ET) ^(f)	hours/day	--	1	--	1	--
Surface Area (SA) ⁽ⁱ⁾	cm ²	--	3300	--	3300	--
Conversion Factor (CF)	mg/cm ³ per ug/l	--	0.000001	--	0.000001	--
Permeability Constant (PC)	cm/hour	-----Chemical specific - See Table 7-----				
Dermal Contact With Groundwater						
Exposure Frequency (EF)	days/year	--	--	--	5 f	--
Exposure Time (ET)	hours/day	--	--	--	1 f	--
Conversion Factor (CF)	kg/mg	--	--	--	0.000001	--
Surface Area (SA) ⁽ⁱ⁾	cm ²	--	--	--	3300	--
Permeability coefficient (PC)	cm/hour	-----Chemical specific - See Table 7-----				
Inhalation of Particulate in Soil						
Inhalation Rate (InhR) ^(g)	m ³ /hour	2.8	2.8	2.8	2.8	2.8
Exposure Rate (ER) ^(f)	hours/day	1	2	2	8	2.8
Particulate Emission Factor (PEF)	m ³ /kg	1.24E+09	1240000000	1.24E+09	1240000000	2.8

Table 6
Exposure Parameters
Human Health Risk Assessment
Landfill 1, O'Hare ARS

Parameter	Units	Mower	Maintenance Workers	On-Site Workers	Construction Workers	Trespasser
Inhalation of Volatile in Groundwater						
Inhalation Rate (InhR) ^(g)	m ³ /day	--	--	20	--	--

-- Exposure route not applicable.

Unless otherwise noted, parameter values are from Illinois Administrative Code Title 35, Part 742, Tiered Approach to Corrective Action Objectives.

- (a) Assumes mowers work at the site three days per year.
- (b) Assumes on-site workers work at the site two days per week, half year per year.
- (c) Assumes teenagers ages 7 to 17 recreating twice per week during the warmer half of the year.
- (c) Assumes teenagers ages 7 to 16 recreating 30 days per year. With steep banks, swampy conditions, and high concentrations of mosquitoes, the area appears to be less attractive than Silver Creek. Also, no one has been observed using this area. Exposure frequency set equal to hunters.
- (d) Mean body weight of boys and girls, ages 7 to 17 (USEPA, 1997)
- (e) Exposure duration x 365 days/year.
- (f) Assumed value.
- (g) Exposure Factors Handbok (USEPA, 1995)
- (h) Mark Johnson, U.S. EPA Region V.
- (i) RAGS, Part E (USEPA, 2001)
- (j) Assumed to be the same as soil adherence factor

Table 7
Toxicity Values for Chemicals of Potential Concern
Human Health Risk Assessment
Landfill 1, O'Hare ARS

	Noncancer Effects					Cancer Effects					Dermal Absorption	Oral Absorption unitless	Permeability Constant (cm/hr)
	Chronic Oral RfD mg/kg-day	Chronic Dermal RfD (a) mg/kg-day	Chronic Inhalation RfC (mg/m3)	Chronic Inhalation RfD (b) mg/kg-day	Target Organ/System or Critical Effect	Oral SF (mg/kg-day)-1	Dermal SF (c) (mg/kg-day)-1	Inhalation URF (ug/m3)-1	Inhalation SF (d) (mg/kg-day)-1	EPA Weight of Evidence Classification			
PCBs/Pesticides													
Aroclor 1254	2.0E-05 I	2.0E-05	NA	NA	NA	NA	NA	NA	NA	NA	0.14 f	96% f	NA
Volatile Organic Compounds													
Benzene	4.0E-03	4.0E-03	3.0E-02 I	8.6E-03	NA	5.5E-02 I	5.5E-02	7.8E-06 I	2.7E-02	A	0 f	>50% f	0.015 f
Ethylbenzene	1.0E-01 I	1.0E-01	1.0E+00 I	2.9E-01	Liver, kidney, and developmental toxicity	NA	NA	NA	NA	D	0 f	>50% f	0.049 f
Methylene Chloride	NA	NA	9.0E-02 I	2.6E-02	NA	NA	NA	NA	NA	D	0 f	>50% f	0.0035 f
Trichloroethene	3.0E-04 E	3.0E-04	4.0E-02 E	1.1E-02	NA	4.0E-01 E	4.0E-01	1.4E-03 E	4.0E-01 E	NA	0 f	>50% f	0.012 f
Semivolatile Organic Compounds													
Benzo(a)anthracene	NA	NA	NA	NA	NA	7.3E-01 E	7.3E-01	8.9E-05 E	3.1E-01	B2	0.13 f	89% f	0.47 f
Benzo(a)pyrene	NA	NA	NA	NA	NA	7.3E+00 I	7.3E+00	8.9E-04 E	3.1E+00	B2	0.13 f	89% f	0.7 f
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	7.3E-01 E	7.3E-01	8.9E-05 E	3.1E-01	B2	0.13 f	89% f	0.7 f
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	7.3E-02 E	7.3E-02	8.9E-06 E	3.1E-02	B2	0.13 f	89% f	NA
Chrysene	NA	NA	NA	NA	NA	7.3E-03 E	7.3E-03	8.9E-07 E	3.1E-03	B2	0.13 f	89% f	0.47 f
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	7.3E+00 E	7.3E+00	8.9E-04 E	3.1E+00	B2	0.13 f	89% f	1.5 f
Indeno(1,2,3-c,d)pyrene	NA	NA	NA	NA	NA	7.3E-01 E	7.3E-01	8.9E-05 E	3.1E-01	B2	0.13 f	89% f	1 f
Naphthalene	2.0E-02 I	2.0E-02	3.0E-03 I	8.6E-04	Respiratory system	NA	NA	NA	NA	C	0.13 f	89% f	0.047 f
Metals													
Arsenic	3.0E-04 I	3.0E-04	NA	NA	Respiratory system	1.5E+00 I	1.5E+00	4.3E-03 I	1.5E+01	A	0.03 f	95% f	0.001 f
Cadmium	5.0E-04 I	2.5E-05	NA	NA	Kidney	NA	NA	1.8E-03 I	6.3E+00	B1	0.001 f	5% f	0.001 f
Manganese	4.6E-02 I,g	1.8E-03	5.0E-05 I	1.4E-05	Central nervous system	NA	NA	NA	NA	D	0.01 f	4% f	0.001 f

Notes:

- a Dermal RfD = Oral RfD x Oral Absorption, if the oral absorption efficiency was less than 50 percent; otherwise, Dermal RfD = Oral RfD (EPA, 2001).
- b RfD (mg/kg-day) = RfC (mg/m3)*20 (m3/day)/70 (kg)
- c Dermal SF = Oral SF/Oral Absorption if the oral absorption efficiency was less than 50 percent; otherwise, Dermal SF = Oral SF (EPA, 2001).
- d SF (mg/kg-day)-1 = URF (ug/m3)-1*70kg*1000(ug/mg)/20(m3/day)
- f EPA, 2001
- g IRIS has an oral RfD of 1.4E-01 mg/kg/day. It is recommended that a modifying factor of 3 be applied if this RfD is used for assessments involving nondietary exposures (IRIS, 2003)
- A Known human carcinogen
- B1 Probable human carcinogen based on limited data in humans
- B2 Probable human carcinogen based on sufficient information in animals
- C Possible human carcinogen
- D No evidence of carcinogenicity
- E EPA National Center for Environmental Assessment provisional value cited in EPA, 2002
- H Health Effects Assessment Summary Tables (HEAST) (EPA, 1997)
- I Integrated Risk Information System (IRIS) database, searched April 2003

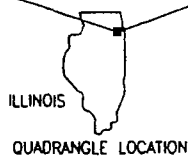
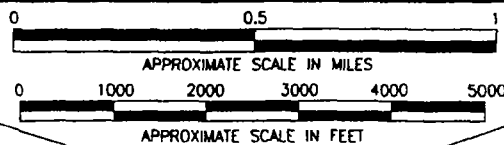
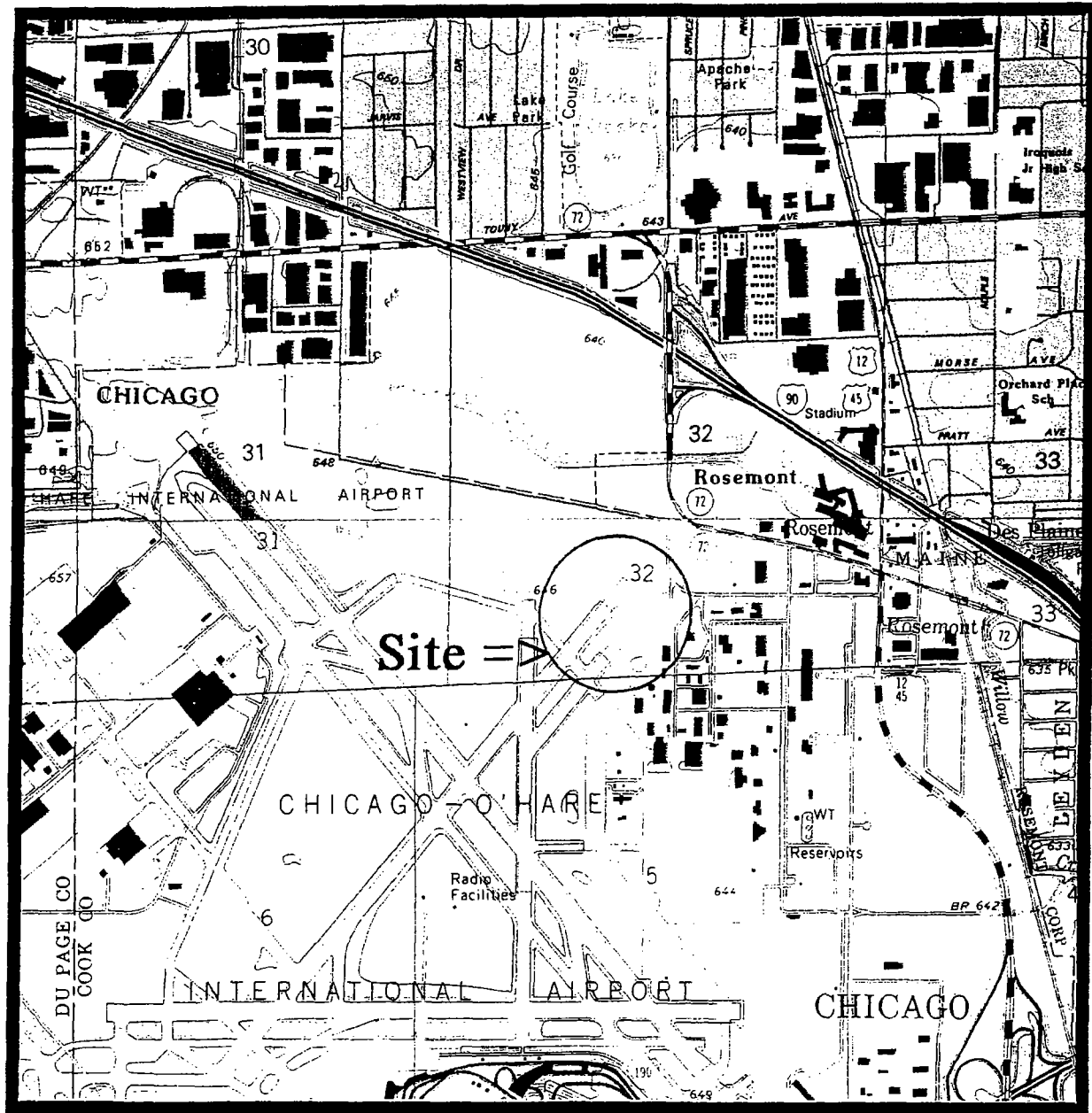
Table 8
Summary of Estimated Risks - Soil, Sediment, Surface Water and Groundwater
Human Health Risk Assessment
Landfill 1, O'Hare ARS

	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
Soil					
Total ELCR	3.E-12	4.E-10	9.E-11	8.E-11	6.E-11
Total HI	2.E-04	2.E-02	2.E-03	1.E-01	3.E-03
Sediment					
Total ELCR	0.E+00	1.E-07	0.E+00	1.E-08	0.E+00
Total HI	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00
Groundwater					
Total ELCR	0.E+00	0.E+00	0.E+00	5.E-07	0.E+00
Total HI	0.E+00	0.E+00	0.E+00	8.E-03	0.E+00
Surface Water					
Total ELCR	0.E+00	1.E-09	0.E+00	6.E-11	0.E+00
Total HI	0.E+00	1.E-03	0.E+00	2.E-03	0.E+00
Summary of Risk to Soil, Sediment, Surface Water and Groundwater					
Total ELCR	3.E-12	1.E-07	9.E-11	6.E-07	6.E-11
Total HI	2.E-04	2.E-02	2.E-03	1.E-01	1.E-02

FIGURES



SOURCE: U.S. GEOLOGICAL SURVEY: 7.5 MINUTE SERIES (TOPOGRAPHIC)
ARLINGTON HEIGHTS, ILLINOIS QUADRANGLE; DATED 1963; AND
ELMHURST, ILLINOIS QUADRANGLE; DATED 1993.



O'HARE AIR RESERVE STATION
CHICAGO, ILLINOIS

PROJECT NO. 11-4599-2808



LAW
ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

9810 BLUEGRASS PARKWAY
LOUISVILLE, KENTUCKY 40299 (502) 495-5800
FAX (502) 495-5801

SITE LOCATION MAP

CADD FILE: 960296
PLOT DATE: 3/20/96

FIGURE 1



- LEGEND:
- Pathway Complete and Significant
 - Pathway Complete but Insignificant
 - △ Pathway Incomplete

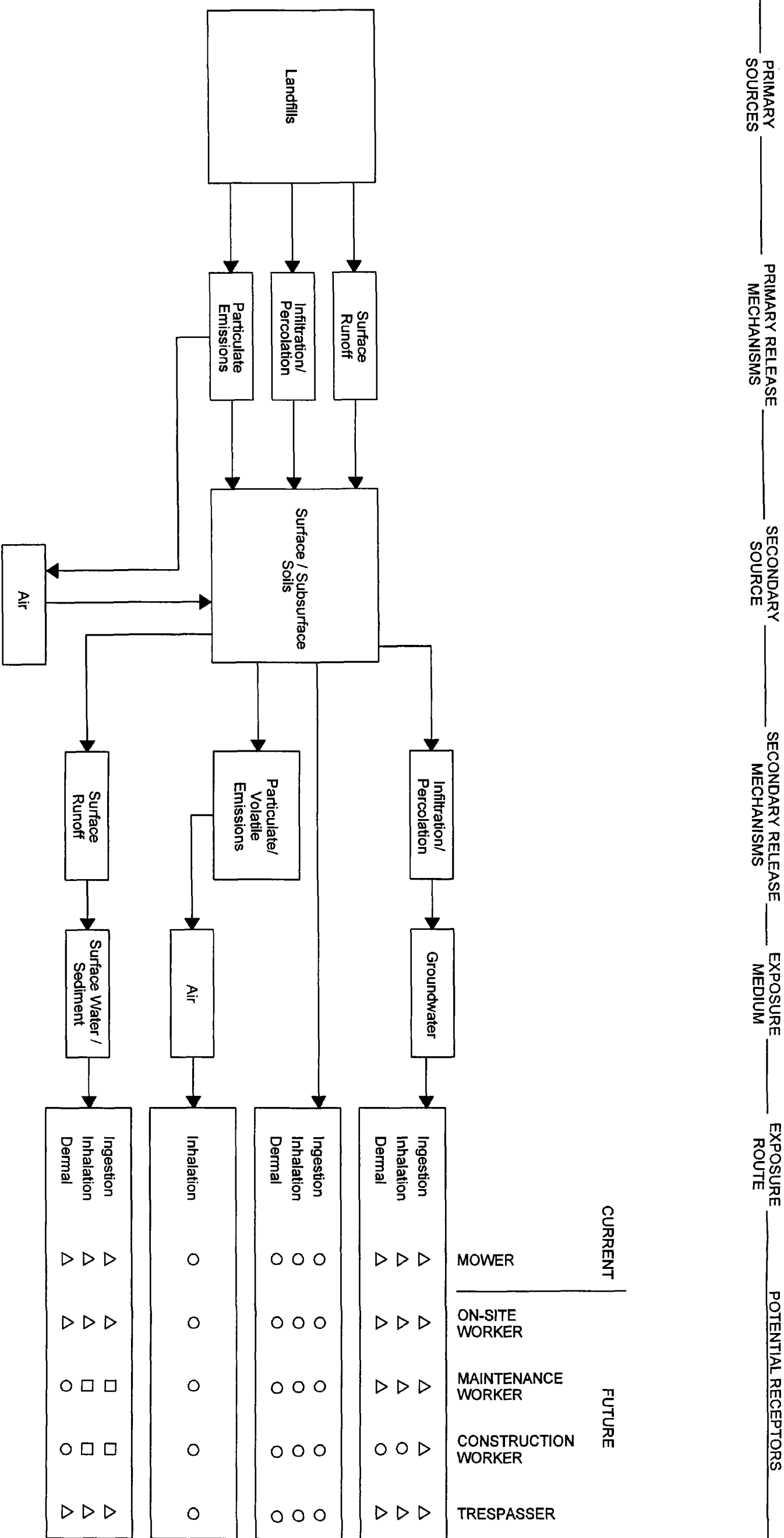


Figure 2 HUMAN HEALTH RISK ASSESSMENT CONCEPTUAL SITE MODEL

LANDFILL 1 REMEDIAL INVESTIGATION
O'Hare Air Reserve Station
Chicago, Illinois



APPENDIX A
ESI ANALYTICAL DATA

Table 2: Summary of Detected Constituents in Soil and Sediment

Sample Location Sampling Date	L-01-001SB (10/24/95)	L-02-001SB (10/24/95)	L-DUP-001SB (L-02-001SB)	L-03-001SB (10/24/95)	L-04-001SB (10/24/95)	L05-001SB (10/25/95)	L-DUP-002SB (L-05-001SB)
Sample Collection Depth (feet bgs)	(8 to 10)	(4 to 6)	(4 to 6)	(4 to 6)	(4 to 6)	(8 to 10)	(8 to 10)
Volatile Organic Compounds - TCL (µg/kg)							
Acetone	ND	ND	ND	ND	17	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	2 (J)	ND	ND	ND	1 (J)	1 (J)	1 (J)
1,2-Dichloroethene, total	ND	ND	ND	ND	ND	ND	ND
Hexane	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	5 (J)	9 (J)	10 (J)	ND	13	10 (J)	2 (J)
Toluene	ND	ND	0.6 (J)	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/kg)							
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	30 (J)	21 (J)	ND	ND
Benzo(a)pyrene	ND	ND	ND	6 (J)	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	50 (J)	31 (J)	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	170 (BJ)	190 (BJ)	91 (BJ)	190 (BJ)	110 (BJ)	79 (BJ)	100 (BJ)
Chrysene	ND	ND	ND	44 (J)	30 (J)	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	5 (J)	ND	ND
Di-n-octylphthalate	ND	ND	ND	79 (J)	ND	ND	ND
Fluoranthene	ND	ND	ND	110 (J)	94 (J)	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	62 (J)	ND	ND	47 (J)	64 (J)	ND	ND
Pyrene	ND	ND	ND	70 (J)	62 (J)	ND	ND

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-01-001SB (10/24/95)	L-02-001SB (10/24/95)	L-DUP-001SB (L-02-001SB)	L-03-001SB (10/24/95)	L-04-001SB (10/24/95)	L05-001SB (10/25/95)	L-DUP-002SB (L-05-001SB)
Sample Collection Depth (feet bgs)	(8 to 10)	(4 to 6)	(4 to 6)	(4 to 6)	(4 to 6)	(8 to 10)	(8 to 10)
Metals - TAL (mg/kg)							
Aluminum	6,940	10,400	8,550	10,900	10,700	9,100	10,900
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	6.6	7.2	6.3	4.2	4.6	4.6	4.7
Barium	31.3 (B)	48.0	58.3	87.5	99.8	47.2	52.2
Beryllium	ND	ND	ND	0.56 (B)	0.51 (B)	ND	ND
Cadmium	2.8	3.6	4.3	5.5	1.6	1.3	1.7
Calcium	112,000 (E)	71,700 (E)	71,400 (E)	3,980 (E)	4,290 (E)	60,100 (E)	61,700 (E)
Chromium	14.9	21.9	18.3	21.0	16.0	23.2	23.6
Cobalt	5.0 (B)	13.2	35.6	18.4	10.3	11.4	13.6
Copper	22.5	29.4	28.9	41.5	19.3	20.0	24.2
Cyanide	ND	ND	ND	ND	ND	ND	ND
Iron	17,000	22,700	23,100	31,700	15,500	19,100	22,100
Lead	11.4	13.3	13.5	161	28.2	10.9	11.0
Magnesium	60,300	31,800	35,600	4680	3150	24,300	27,300
Manganese	385 (E)	462 (E)	1,160 (E)	553 (E)	351 (E)	393 (E)	439 (E)
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	21.0	33.0	69.2	37.7	15.3	31.3	36.3
Potassium	1,530	2,000	1,660	950	1,190	1,860	2,330
Selenium	ND	ND	ND	ND	0.40 (B)	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	199 (B)	168 (B)	190 (B)	83.6 (B)	66.0 (B)	177 (B)	205 (B)
Thallium	0.28 (B)	0.58 (BM)	0.92 (B)	0.53 (B)	0.28 (B)	0.43 (B)	0.41 (B)
Vanadium	17.2	25.1	22.6	29.3	25.6	25.8	29.0
Zinc	38.2	56.8	59.1	74.1	65.8	65.1	54.7
Pesticides - TCL (µg/l)							
4,4'-DDD	ND	ND	ND	ND	0.83 (J)	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	0.45 (JP)	0.23 (JP)	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	0.61 (JP)	ND	ND
PCBs - TCL (µg/l)							
Aroclor 1254	ND	ND	ND	ND	ND	ND	ND

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-06-001SB (10/24/95)	L-07-001SB (10/26/95)	L-08-001SB (10/26/95)	L-09-001SB (10/26/95)	L-10-001SB (10/25/95)	L-11-001SB (10/26/95)	L-12-001SB (10/26/95)
Sample Collection Depth (feet bgs)	(8 to 10)	(2 to 4)	(8 to 10)	(4 to 6)	(8 to 10)	(8 to 10)	(13 to 15)
Volatile Organic Compounds - TCL (µg/kg)							
Acetone	ND	ND	ND	ND	18	26	ND
Benzene	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND	ND	ND	ND	ND	1 (J)	1 (J)
1,2-Dichloroethene, total	ND	ND	ND	ND	ND	ND	ND
Hexane	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	5 (J)	ND	2 (J)	10 (J)	2 (J)	1 (J)	6 (J)
Toluene	3 (J)	ND	0.9 (J)	3 (J)	1 (J)	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/kg)							
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	39 (J)	ND	ND
Benzo(a)anthracene	ND	150 (J)	ND	ND	69 (J)	17 (J)	21 (J)
Benzo(a)pyrene	ND	150 (J)	ND	ND	34 (J)	ND	ND
Benzo(b)fluoranthene	ND	290	ND	ND	120 (J)	52 (J)	14 (J)
Benzo(g,h,i)perylene	ND	19 (J)	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	86 (BJ)	190 (B)	78 (BJ)	130 (BJ)	70 (BJ)	35 (BJ)	150 (BJ)
Chrysene	ND	180	ND	ND	78 (J)	7 (J)	10 (J)
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	4 (J)	ND	ND	ND	ND	ND
Di-n-octylphthalate	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	410	ND	ND	270	100 (J)	130 (J)
Fluorene	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	50 (J)	ND	ND	ND	ND	ND
Napthalene	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	ND	ND	ND	ND	ND
2-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	210	ND	ND	230	48 (J)	150 (J)
Pyrene	ND	320	ND	ND	200 (J)	87 (J)	82 (J)

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-06-001SB (10/24/95)	L-07-001SB (10/26/95)	L-08-001SB (10/26/95)	L-09-001SB (10/26/95)	L-10-001SB (10/25/95)	L-11-001SB (10/26/95)	L-12-001SB (10/26/95)
Sample Collection Depth (feet bgs)	(8 to 10)	(2 to 4)	(8 to 10)	(4 to 6)	(8 to 10)	(8 to 10)	(13 to 15)
Metals - TAL (mg/kg)							
Aluminum	6,570	6,370	10,500	10,300	8,840	9,430	10,900
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	8.2	5.7	9.1	6.1	2.0	7.4	6.5
Barium	82.6	56.3	47.5	65.3	74.5	132	64.0
Beryllium	0.39 (B)	ND	ND	ND	0.59 (B)	ND	ND
Cadmium	1.9	2.3	4.2	2.6	0.95	7.0	2.8
Calcium	33,500 (E)	56,500	51,900	62,500 (E)	12,800	56,900	62,200
Chromium	13.2	13.1	19.9	21.4	13.2	32.1	21.0
Cobalt	14.6	7.4 (B)	11.0	20.8	5.9 (B)	11.6	12.6
Copper	30.7	29.6	26.1	29.7	16.6	134	23.2
Cyanide	ND	ND	ND	ND	ND	ND	ND
Iron	26,000	14,300	22,200	23,700	12,900	38,200	22,900
Lead	18.3	219	17.5	12.8	21.8 (S)	231	12.5
Magnesium	20,300	30,100	30,300	27,400	9,240	28,500	25,400
Manganese	764 (E)	422	357	1,110 (E)	292	704	409
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	32.9	20.0	32.1	47.4	16.9	54.8	35.5
Potassium	773 (B)	1,310 (E)	1,610 (E)	1,720	793 (BE)	1,430 (E)	2,260 (E)
Selenium	0.27 (B)	0.19 (BN)	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	105 (B)	110 (B)	131 (B)	129 (B)	114 (B)	218 (B)	205 (B)
Thallium	0.35 (B)	0.26 (B)	0.37 (B)	0.42 (B)	0.18 (B)	0.47 (B)	0.34 (B)
Vanadium	24.1	18.0	20.3	26.9	18.8	27.0	23.5
Zinc	76.8	73.1	56.5	59.0	56.7	323	53.0
Pesticides - TCL (µg/l)							
4,4'-DDD	ND	ND	ND	ND	ND	6.0	ND
4,4'-DDE	ND	2.1 (JP)	ND	ND	ND	2.5 (JP)	ND
4,4'-DDT	ND	2.3 (JP)	ND	ND	ND	0.51 (JP)	ND
Dieldrin	ND	1.0 (JP)	ND	ND	ND	0.33 (JP)	ND
Endosulfan I	ND	ND	ND	ND	ND	0.56 (JP)	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	0.88 (JP)	ND
Endrin Ketone	ND	ND	ND	ND	ND	2.0 (JP)	0.47 (JP)
gamma-Chlordane	ND	ND	ND	ND	ND	1.9 (JP)	ND
Heptachlor	ND	0.39 (JP)	ND	ND	ND	0.47 (JP)	ND
Methoxychlor	ND	1.3 (BJP)	ND	ND	ND	ND	0.59 (BJP)
PCBs - TCL (µg/l)							
Aroclor 1254	ND	ND	ND	ND	ND	140 (P)	ND

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-13-001SB (10/26/95)	L-14-001SB (10/26/95)	L-15-001SB (10/26/95)	L-16-001SB (10/26/95)	L-17-001SB (10/26/95)	L-DUP-008SB (L-17-001SB)	L-18-001SB (10/26/95)
Sample Collection Depth (feet bgs)	(4 to 6)	(13 to 15)	(13 to 15)	(13 to 15)	(13 to 15)	(13 to 15)	(8 to 10)
Volatile Organic Compounds - TCL (µg/kg)							
Acetone	59	8 (J)	ND	ND	ND	ND	22
Benzene	3 (J)	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	7 (J)	1 (J)	0.7 (J)	2 (J)	2 (J)	2 (J)	3 (J)
1,2-Dichloroethene, total	ND	ND	ND	ND	ND	ND	ND
Hexane	ND	ND	ND	ND	ND	ND	9 (JN)
Methylene Chloride	16 (J)	ND	ND	2 (J)	1 (J)	1 (J)	3 (J)
Toluene	ND	ND	ND	ND	ND	ND	2 (J)
Trichloroethene	ND	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/kg)							
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	630 (BJ)	69 (BJ)	84 (BJ)	66 (BJ)	38 (BJ)	42 (BJ)	20 (BJ)
Chrysene	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND
Di-n-octylphthalate	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND	ND	ND	ND	ND
Napthalene	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-di-n-propylamine	ND	ND	ND	ND	ND	ND	ND
2-Methylnapthalene	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	22 (J)	16 (J)	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-13-001SB (10/26/95)	L-14-001SB (10/26/95)	L-15-001SB (10/26/95)	L-16-001SB (10/26/95)	L-17-001SB (10/26/95)	L-DUP-008SB (L-17-001SB)	L-18-001SB (10/26/95)
Sample Collection Depth (feet bgs)	(4 to 6)	(13 to 15)	(13 to 15)	(13 to 15)	(13 to 15)	(13 to 15)	(8 to 10)
Metals - TAL (mg/kg)							
Aluminum	3,590	9,580	9,950	8,540	9,290	10,100	6,760
Antimony	4.4 (B)	ND	ND	ND	ND	ND	ND
Arsenic	9.3	4.3	4.8	4.6	6.4	6.6 (B)	5.3 (B)
Barium	54.8	56.4	49.4	34.8 (B)	49.4	53.4	27.1 (B)
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	5.3	3.5	4.5	2.8	1.6	ND	ND
Calcium	80,600	62,300	68,000	67,000	61,600 (E)	66,000 (E)	81,300 (E)
Chromium	68.3	22.7	18.9	17.1	16.8	21.7	15.6
Cobalt	4.2 (B)	13.3	12.9	11.4	12.8	12.6	11.9
Copper	2,100	23.5	24.9	23.5	26.8	29.6	25.9
Cyanide	ND	ND	ND	ND	ND	ND	ND
Iron	22,700	23,600	23,700	20,200	20,100	21,700	17,100
Lead	ND	ND	9.7	ND	12.3	12.0	15.8
Magnesium	45,200	25,900	30,500	30,000	31,600	30,900	44,300
Manganese	366	406	448	393	422	437	633
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	29.1	34.1	34.5	31.1	33.4	36.7	31.1
Potassium	673 (BE)	2,030 (E)	2,170 (E)	1,890 (E)	2,080	2,200	1,450
Selenium	0.33 (BN)	ND	ND	ND	ND	ND	0.24 (B)
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	191 (B)	185 (B)	202 (B)	191 (B)	152 (B)	173 (B)	142 (B)
Thallium	0.36 (B)	ND	0.24 (B)	0.38 (B)	0.42 (B)	0.37 (B)	0.66 (B)
Vanadium	14.8	25.6	21.6	23.1	25.1	27.2	19.9
Zinc	1,380	54.1	53.6	49.6	50.7	50.9	80.5
Pesticides - TCL (µg/l)							
4,4'-DDD	25 (JP)	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	0.26 (JP)	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	7.3 (JP)	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	83 (P)	ND	ND	ND	ND	ND	ND
gamma-Chlordane	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	0.46 (BJP)	ND	ND	ND	1.2 (BJ)	ND
PCBs - TCL (µg/l)							
Aroclor 1254	ND	ND	ND	ND	ND	ND	ND

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-BG1-001SB (10/16/95)	L-BG1-002SB (10/16/95)	L-BG2-001SB (10/26/95)	L-BG2-002SB (10/26/95)	L-01-002SD (1/22/96)	L-02-002SD (1/22/96)	* L-DUP-010SD (L-02-002SD)
Sample Collection Depth (feet bgs)	(5 to 7)	(13 to 15)	(7 to 9)	(13 to 15)	(0.0 TO 0.5)	(0.0 TO 0.5)	(0.0 TO 0.5)
Volatile Organic Compounds - TCL (µg/kg)							
Acetone	--	ND	--	ND	ND	73	110
Benzene	--	ND	--	ND	ND	ND	ND
2-Butanone	--	ND	--	ND	ND	13 (J)	21
Carbon Disulfide	--	ND	--	1 (J)	ND	ND	ND
1,2-Dichloroethene, total	--	ND	--	ND	ND	8 (J)	6 (J)
Hexane	--	ND	--	ND	ND	ND	ND
Methylene Chloride	--	ND	--	3 (J)	ND	ND	ND
Toluene	--	ND	--	1 (J)	ND	ND	ND
Trichloroethene	--	ND	--	ND	ND	1 (J)	1 (J)
Semi-Volatile Organic Compounds - TCL (µg/kg)							
Acenaphthene	--	ND	--	ND	100 (J)	120 (J)	21 (J)
Anthracene	--	ND	--	ND	240 (J)	330 (J)	37 (J)
Benzo(a)anthracene	--	ND	--	ND	570 (J)	1,600	210 (J)
Benzo(a)pyrene	--	ND	--	ND	590 (J)	2,000	310 (J)
Benzo(b)fluoranthene	--	ND	--	ND	850	3,200	410
Benzo(g,h,i)perylene	--	ND	--	ND	380 (J)	1,600	230 (J)
Benzo(k)fluoranthene	--	ND	--	ND	250 (J)	1,000	180 (J)
bis(2-Ethylhexyl)phthalate	--	140 (BJ)	--	69 (BJ)	95(J)	490	100(J)
Butylbenzylphthalate	--	ND	--	ND	ND	39 (J)	24 (J)
Chrysene	--	ND	--	ND	690	2,400	310 (J)
Dibenz(a,h)anthracene	--	ND	--	ND	59 (J)	330 (J)	ND
Dibenzofuran	--	ND	--	ND	54 (J)	99 (J)	12 (J)
Diethylphthalate	--	ND	--	ND	ND	8 (J)	ND
Di-n-butylphthalate	--	ND	--	ND	16(J)	23(J)	16(J)
Di-n-octylphthalate	--	ND	--	ND	ND	ND	ND
Fluoranthene	--	ND	--	ND	1,500	4,000	510 (J)
Fluorene	--	ND	--	ND	110 (J)	200 (J)	20 (J)
Indeno(1,2,3-cd)Pyrene	--	ND	--	ND	420 (J)	1,700	220 (J)
Napthalene	--	ND	--	ND	40 (J)	37 (J)	16 (J)
N-Nitroso-di-n-propylamine	--	620	--	ND	ND	ND	ND
2-Methylnapthalene	--	ND	--	ND	23 (J)	30 (J)	10 (J)
Phenanthrene	--	ND	--	ND	1,100	1,500	290 (J)
Phenol	--	ND	--	ND	ND	11 (J)	11 (J)
Pyrene	--	ND	--	ND	1,500	4,300	600

* The analytical results for sample L-DUP-010SD are combined from samples L-02-002SD (volatiles) and L-01-002SD (semi-volatiles, metals, pesticides, PCBs)

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Sample Location Sampling Date	L-BG1-001SB (10/16/95)	L-BG1-002SB (10/16/95)	L-BG2-001SB (10/26/95)	L-BG2-002SB (10/26/95)	L-01-002SD (1/22/96)	L-02-002SD (1/22/96)	L-DUP-010SD (L-02-002SD)
Sample Collection Depth (feet bgs)	(5 to 7)	(13 to 15)	(7 to 9)	(13 to 15)	(0.0 TO 0.5)	(0.0 TO 0.5)	(0.0 TO 0.5)
Metals - TAL (mg/kg)							
Aluminum	10,500	8,480	4,430	9,320	5,930	6,210	4,960
Antimony	ND	ND	ND	ND	14.7	14.7 (N)	13.1 (N)
Arsenic	9.8	6.5	3.9	5.2	5.0	4.5	2.2
Barium	120	48.5	29.0 (B)	47.3	71.6	100	125
Beryllium	0.55 (B)	ND	ND	ND	0.89	0.95	0.74 (B)
Cadmium	ND	ND	3.8	3.1	ND	ND	ND
Calcium	18,900	58,600	153,000	69,100	33,600	42,800	26,900
Chromium	17.0	18.2	9.4	18.4	10.8	11.5	12.5
Cobalt	10.6	10.5	6.6 (B)	12.6	7.6 (B)	9.0 (B)	6.9 (B)
Copper	23.0	28.0	26.0	21.8	25.0	30.4	18.3
Cyanide	ND	ND	ND	ND	ND	ND	ND
Iron	22,500	21,300	15,000	22,200	12,800	13,700	10,700
Lead	27.2	12.5	ND	18.5 (S)	28.0	23.6	16.7
Magnesium	11,600	27,800	26,300	30,400	7,380	19,700	7,660
Manganese	1,490	406	434	439	309	236	297
Mercury	0.09	ND	ND	ND	ND	ND	ND
Nickel	39.7	30.9	21.1	31.2	12.9	18.8	11.1
Potassium	793 (B)	1,830	880 (BE)	2,070 (E)	540 (B)	965	436 (B)
Selenium	ND	ND	0.30 (BN)	ND	ND	0.19 (B)	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	74.7 (B)	117 (B)	185 (B)	124 (B)	353 (B)	74.6 (B)
Thallium	0.51 (B)	0.59 (B)	0.38 (B)	0.36 (B)	0.19 (B)	0.26 (B)	ND
Vanadium	28.2	24.3	11.1	21.4	11.7	11.9	9.8
Zinc	52.2	58.4	34.2	52.2	79.7	162	194
Pesticides - TCL (µg/l)							
4,4'-DDD	--	ND	--	ND	ND	ND	ND
4,4'-DDE	--	ND	--	ND	ND	ND	1.2 (JP)
4,4'-DDT	--	ND	--	ND	ND	3.1 (JP)	ND
Dieldrin	--	ND	--	ND	ND	1.1 (JP)	ND
Endosulfan I	--	ND	--	ND	ND	ND	ND
Endosulfan II	--	ND	--	ND	ND	ND	ND
Endrin	--	ND	--	ND	ND	1.3 (JP)	ND
Endrin Ketone	--	ND	--	0.27 (JP)	ND	ND	ND
gamma-Chlordane	--	ND	--	ND	ND	ND	ND
Heptachlor	--	ND	--	ND	ND	ND	ND
Methoxychlor	--	ND	--	ND	ND	ND	ND
PCBs - TCL (µg/l)							
Aroclor 1254	--	ND	--	ND	ND	ND	ND

Table 2: Summary of Detected Constituents in Soil and Sediment - Continued

Notes

TCL - Target Compound List

TAL - Target Analyte List

B - Analyte was found in the associated blank as well as the sample

E - Compounds whose concentrations exceed the calibration range of the GC/MS instrument for that specific analysis

J - Estimated Value

N - Presumptive evidence of a compound

P - Greater than 25% difference for detected concentrations between the two GC columns

µg/kg - Micrograms per kilogram

mg/kg - Milligrams per kilogram

ND - Not detected above practical quantitation limits

-- - Not analyzed

S - The reported value was determined by the Method of Standard Additions (MSA)

bgs - Below ground surface

Prepared/Date: SLQ 1/19/96

Checked/Date: DPD 2/5/96

Table 3: Summary of Detected Constituents in the Upper Zone

Sample Location Sampling Date	MW-1F (11/14/95)	MW-1G (11/14/95)	LF1-01A (11/14/95)	LF1-02A (11/14/95)	LF1-03A (11/14/95)	L-01A-001MW (11/16/95)
Volatile Organic Compounds - TCL (µg/l)						
1,2-Dichloroethene (Total)	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND
Methylene Chloride	1 (J)	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND
Xylene (Total)	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/l)						
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)Pyrene	ND	ND	ND	ND	ND	ND
Benzo(b)Fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)Perylene	ND	ND	ND	ND	ND	ND
Benzo(k)Fluoranthene	ND	ND	ND	ND	ND	ND
Bis(2-Ethylhexyl)Phthalate	0.2 (BJ)	ND	ND	ND	ND	0.8 (BJ)
Chrysene	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND
Di-N-Butylphthalate	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND
Metals - TAL (mg/l)						
Aluminum	14.8 (EN)	5.3 (EN)	0.479	2.52	15.6 (EN)	2
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	0.0126 (S)	0.0055 (B)	0.0018 (B)	0.0039 (B)	0.0129 (S)	0.0016 (BN)

Table 3: Summary of Detected Constituents in the Upper Zone--Continued

Sample Location Sampling Date	MW-1F (11/14/95)	MW-1G (11/14/95)	LF1-01A (11/14/95)	LF1-02A (11/14/95)	LF1-03A (11/14/95)	L-01A-001MW (11/16/95)
Metals - TAL (mg/l)--Continued						
Barium	0.128 (B)	0.0746 (B)	0.0404 (B)	0.0846 (B)	0.142 (B)	0.0787 (B)
Beryllium	ND	ND	ND	ND	ND	ND
Cadmium	0.0037 (B)	0.0048 (B)	ND	ND	ND	ND
Calcium	200	164	120	91.8	275	104
Chromium	0.126	0.0364	ND	0.0202	0.0332	0.0353
Cobalt	0.0152 (B)	ND	ND	0.011 (B)	0.0206 (B)	ND
Copper	0.072	0.041	0.0174 (B)	0.0255	0.0843	0.0344
Cyanide	ND	ND	ND	ND	ND	ND
Iron	32.5	11.9	2.03	7.88	40.1	4.71
Lead	0.0213	0.0089	0.0021 (B)	0.0066	0.0264	0.0042
Magnesium	118	86.3	63.1	49.1	145	59.1
Manganese	0.72 (EN)	0.53 (EN)	0.258	0.616	1.26 (EN)	0.466
Mercury	ND	ND	ND	ND	ND	ND
Nickel	0.108	0.055	ND	ND	0.0589	0.0282 (B)
Potassium	7.34	4.14 (B)	3.04 (B)	3.49 (B)	9.92	3.88 (B)
Selenium	0.0012 (BN)	0.0014 (BN)	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND
Sodium	21	29.6	23.3	34.2	40.7	39.6
Thallium	ND	ND	ND	ND	ND	ND
Vanadium	0.026 (B)	0.0105 (B)	ND	ND	0.0312 (B)	ND
Zinc	0.0784	0.0296	0.0081 (B)	0.0274	0.103	0.0192 (B)
Pesticides - TCL (µg/l)						
4,4'-DDD	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND
Anions (mg/l)						
Chloride	20	12	8.9	8	23	26
Fluoride	0.22	0.087 (J)	0.23	0.47	0.22	0.31
Nitrate-N	0.069	0.46	0.08	0.18	0.046 (J)	0.029 (J)
Sulfate	200	220	260	120	340	130
Total Dissolved Solids (mg/l)	690	750	710	490	790	590

Table 3: Summary of Detected Constituents in the Upper Zone--Continued

Sample Location Sampling Date	L-02A-001MW (11/17/95)	L-03A-001MW (11/16/95)	L-DUP-006MW (L-03A-001MW)	L-04A-001MW (11/17/95)	L-06A-001MW (11/17/95)	L-07A-001MW (11/16/95)
Volatile Organic Compounds - TCL (µg/l)						
1,2-Dichloroethene (Total)	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	9 (J)	ND
Carbon Disulfide	ND	ND	ND	ND	0.8 (J)	ND
Ethylbenzene	ND	ND	ND	ND	5 (J)	ND
Methylene Chloride	3 (J)	ND	ND	ND	1 (J)	ND
Toluene	ND	ND	ND	ND	2 (J)	ND
Trichloroethene	ND	ND	ND	ND	ND	ND
Xylene (Total)	ND	ND	ND	ND	9 (J)	ND
Semi-Volatile Organic Compounds - TCL (µg/l)						
2-Methylnaphthalene	ND	ND	ND	ND	18	ND
Acenaphthene	ND	ND	ND	ND	78	ND
Anthracene	ND	ND	ND	ND	32	ND
Benzo(a)Anthracene	ND	ND	ND	ND	15	ND
Benzo(a)Pyrene	ND	ND	ND	ND	9	ND
Benzo(b)Fluoranthene	ND	ND	ND	ND	15	ND
Benzo(g,h,i)Perylene	ND	ND	ND	ND	2 (J)	ND
Benzo(k)Fluoranthene	ND	ND	ND	ND	4 (J)	ND
Bis(2-Ethylhexyl)Phthalate	ND	ND	ND	0.6 (J)	ND	0.6 (BJ)
Chrysene	ND	ND	ND	ND	15	ND
Dibenzofuran	ND	ND	ND	ND	41	ND
Diethylphthalate	ND	ND	ND	ND	2 (J)	ND
Di-N-Butylphthalate	ND	ND	ND	ND	ND	0.1 (J)
Fluoranthene	ND	ND	ND	ND	80	ND
Fluorene	ND	ND	ND	ND	63	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND	ND	1 (J)	ND
Naphthalene	ND	ND	ND	ND	120	ND
Phenanthrene	ND	ND	ND	ND	160	ND
Phenol	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	51	ND
Metals - TAL (mg/l)						
Aluminum	5.5	3.17	3.95	8.73	35.5	4.45
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	0.0027 (B)	0.0017 (BN)	0.0013 (BN)	0.0035 (B)	0.006 (B)	0.0019 (BN)

Table 3: Summary of Detected Constituents in the Upper Zone--Continued

Sample Location Sampling Date	L-02A-001MW (11/17/95)	L-03A-001MW (11/16/95)	L-DUP-006MW (L-03A-001MW)	L-04A-001MW (11/17/95)	L-06A-001MW (11/17/95)	L-07A-001MW (11/16/95)
Metals - TAL (mg/l)--Continued						
Barium	0.166 (B)	0.0956 (B)	0.0837 (B)	0.172 (B)	0.527	0.0932 (B)
Beryllium	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND
Calcium	126	153	154	164	234	174
Chromium	0.0628	0.0286	ND	0.0428	0.0772	0.0368
Cobalt	0.0185 (B)	ND	ND	0.0132 (B)	0.0298 (B)	ND
Copper	0.0757	0.041	0.034	0.102	0.1	0.0295
Cyanide	ND	ND	ND	ND	ND	ND
Iron	16.2	6.88	9.21	24	73.7	8.89
Lead	0.0142	0.0081	0.0067	0.02	0.208 (S)	0.0065
Magnesium	61.3	70	71	89.5	175	89.4
Manganese	1.63	0.385	0.296	1.22	1.89	0.362
Mercury	ND	ND	ND	ND	ND	ND
Nickel	0.0456	ND	ND	0.05	0.0996	0.027 (B)
Potassium	4.22 (B)	2.26 (B)	2.2 (B)	6.65	24.5	3.88 (B)
Selenium	ND	0.0013 (BN)	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND
Sodium	8.69	9.35	9.19	45	60.3	20.7
Thallium	ND	ND	ND	ND	0.0012 (B)	ND
Vanadium	0.0163 (B)	ND	0.0069 (B)	0.0198 (B)	0.0902	0.0078 (B)
Zinc	0.0432	0.0264	0.0336	.0772	0.42	0.0304
Pesticides - TCL (µg/l)						
4,4'-DDD	ND	ND	ND	ND	0.0074 (JP)	ND
Endrin	ND	ND	ND	0.022 (JP)	ND	ND
Endrin Ketone	ND	ND	ND	ND	0.024 (JP)	ND
Methoxychlor	ND	ND	ND	ND	0.052 (JP)	ND
Anions (mg/l)						
Chloride	6.2	16	15	100	29	18
Fluoride	0.39	ND	ND	ND	ND	0.064 (J)
Nitrate-N	ND	0.48	0.49	0.04 (J)	ND	ND
Sulfate	60	93	93	290	11	250
Total Dissolved Solids (mg/l)	600	660	650	960	770	830

Table 3: Summary of Detected Constituents in the Upper Zone--Continued

Notes

TCL - Target Compound List

TAL - Target Analyte List

B - Analyte was found in the associated blank as well as the sample

E - Compounds whose concentrations exceed the calibration of the GC/MS instrument for that specific analysis

J - Estimated Value

N - Presumptive evidence of a compound

-- - Did not analyze

µg/l - Micrograms per liter

mg/l - Milligrams per liter

ND - Not detected above practical quantitation limits

P - Greater than 25% difference for detected concentrations between the two GC columns

S - The reported value was determined by the Method of Standard Additions (MSA)

Prepared/Date: SLQ 1/19/96

Checked/Date: DPD 2/5/96

Table 4: Summary of Detected Constituents in the Lower Zone

Sample Location Sampling Date	MW-1A (11/14/95)	MW-1B (11/13/95)	LF1-01 (11/14/95)	L-DUP-005MW (LF1-01)	LF1-02 (11/14/95)	LF1-03 (11/14/95)	L-01B-001MW (11/16/95)
Volatile Organic Compounds - TCL (µg/l)							
1,2-Dichloroethene (Total)	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND	ND	0.9 (J)	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	7 (J)	ND	3 (J)	5 (J)	0.6 (J)	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND
Xylene (Total)	ND	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/l)							
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)Anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)Pyrene	ND	ND	ND	ND	ND	ND	ND
Benzo(b)Fluoranthene	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)Perylene	ND	ND	ND	ND	ND	ND	ND
Benzo(k)Fluoranthene	ND	ND	ND	ND	ND	ND	ND
Bis(2-Ethylhexyl)Phthalate	ND	ND	ND	ND	ND	ND	0.3 (BJ)
Chrysene	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND
Di-N-Butylphthalate	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	0.6 (BJ)	ND	ND	ND	0.6 (BJ)	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND
Metals - TAL (mg/l)							
Aluminum	0.131 (B) (EN)	4.11	0.486 (EN)	0.408 (EN)	0.25 (EN)	2.58	0.563
Antimony	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.0041 (B)	0.0034 (B)	ND	ND	ND	0.0043 (B)	0.0036 (BN)

Table 4: Summary of Detected Constituents in the Lower Zone--Continued

Sample Location Sampling Date	MW-1A (11/14/95)	MW-1B (11/13/95)	LF1-01 (11/14/95)	L-DUP-005MW (LF1-01)	LF1-02 (11/14/95)	LF1-03 (11/14/95)	L-01B-001MW (11/16/95)
Metals - TAL (mg/l)--Continued							
Barium	0.0564 (B)	0.0725 (B)	0.0458 (B)	0.0465 (B)	0.0711 (B)	0.0602 (B)	0.0378 (B)
Beryllium	ND	ND	ND	ND	ND	ND	ND
Cadmium	0.0054	ND	ND	0.004 (B)	ND	ND	ND
Calcium	128	93	65.9	65.4	72.8	162	47.5
Chromium	ND	ND	ND	ND	ND	ND	0.009 (B)
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	0.0287	0.0234 (B)	0.0187 (B)	0.0166 (B)	0.019 (B)	0.0354	0.0263
Cyanide	ND	ND	ND	ND	ND	ND	ND
Iron	2.24	8.67	0.781	0.56	0.498	9.61	0.995
Lead	0.0016 (B)	0.0054	0.0011 (B)	ND	0.0011 (B)	0.0058	0.0017 (B)
Magnesium	52.9	49.1	32.9	32.5	39.3	83.1	23.7
Manganese	0.268 (EN)	0.287	0.175 (EN)	0.0169 (EN)	0.0126 (EN)	0.802	0.0551
Mercury	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	0.012 (B)	ND	ND	ND	0.0136 (B)	ND
Potassium	1.39 (B)	5	2.75 (B)	2.66 (B)	2.84 (B)	4.18 (B)	5.15
Selenium	ND	ND	ND	ND	ND	ND	ND
Silver	ND	ND	ND	ND	ND	ND	ND
Sodium	21.1	56.3	57.2	56.9	51.9	66	57
Thallium	ND	ND	ND	ND	ND	ND	ND
Vanadium	ND	0.012 (B)	ND	ND	ND	0.0073 (B)	ND
Zinc	0.0087 (B)	0.0381	0.0082 (B)	ND	ND	0.0412	0.0078 (B)
Pesticides - TCL (µg/l)							
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND
Anions (mg/l)							
Chloride	12	18	6.3	7.4	6.9	9.5	11
Fluoride	0.14 (J)	0.50	0.56	0.45	0.44	0.41	0.6
Nitrate-N	0.097	0.084 (J)	0.14	0.075	0.08 (J)	0.081 (J)	0.027 (J)
Sulfate	69	120	120	120	110	160	180
Total Dissolved Solids (mg/l)	580	520	480	480	500	560	420

Table 4: Summary of Detected Constituents in the Lower Zone--Continued

Sample Location Sampling Date	L-02B-001MW (11/17/95)	L-03B-001MW (11/16/95)	L-04B-001MW (11/17/95)	L-DUP-007MW (L-04B-001MW)	L-05B-001MW (11/17/95)	L-07B-001MW (11/16/95)
Volatile Organic Compounds - TCL (µg/l)						
1,2-Dichloroethene (Total)	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND
Carbon Disulfide	0.5 (J)	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND
Methylene Chloride	3 (J)	ND	ND	ND	2 (J)	ND
Toluene	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND
Xylene (Total)	ND	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/l)						
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)Pyrene	ND	ND	ND	ND	ND	ND
Benzo(b)Fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)Perylene	ND	ND	ND	ND	ND	ND
Benzo(k)Fluoranthene	ND	ND	ND	ND	ND	ND
Bis(2-Ethylhexyl)Phthalate	0.7 (J)	0.6 (BJ)	ND	ND	ND	0.4 (BJ)
Chrysene	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND
Di-N-Butylphthalate	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	2 (J)
Pyrene	ND	ND	ND	ND	ND	ND
Metals - TAL (mg/l)						
Aluminum	.403	1.01	10.2	1.67	5.15	0.19 (B)
Antimony	ND	ND	ND	ND	ND	ND
Arsenic	ND	0.0015 (BN)	0.0093 (B)	0.003 (B)	0.003 (B)	ND

Table 4: Summary of Detected Constituents in the Lower Zone--Continued

Sample Location Sampling Date	L-02B-001MW (11/17/95)	L-03B-001MW (11/16/95)	L-04B-001MW (11/17/95)	L-DUP-007MW (L-04B-001MW)	L-05B-001MW (11/17/95)	L-07B-001MW (11/16/95)
Metals - TAL (mg/l)--Continued						
Barium	0.0421 (B)	0.0242 (B)	0.105 (B)	0.0396 (B)	0.0801 (B)	0.0233 (B)
Beryllium	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND
Calcium	86.5	36.7	166	32.7	125	24.3
Chromium	0.039	ND	0.0358	0.0218	0.0445	0.372
Cobalt	ND	ND	0.0104 (B)	ND	ND	ND
Copper	0.0193 (B)	0.0212 (B)	0.0654	0.0312	0.0266	0.0203 (B)
Cyanide	ND	ND	ND	ND	ND	ND
Iron	0.738	2.8	29.2	3.83	11.4	0.399
Lead	ND	0.0024 (B)	0.0281	0.0038	0.0049	0.0011 (B)
Magnesium	2.7 (B)	16.3	89.8	28.7	65.3	4.95 (B)
Manganese	0.0606	0.156	0.989	0.125	0.47	0.0226
Mercury	ND	ND	ND	ND	ND	ND
Nickel	0.0206 (B)	ND	0.0708	0.0302 (B)	0.022 (B)	ND
Potassium	23.9	29.6	21.7	19	7.5	444
Selenium	ND	ND	ND	ND	ND	0.0027 (BN)
Silver	ND	ND	ND	ND	ND	ND
Sodium	39.5	56.5	52.6	51.4	46.3	163
Thallium	ND	ND	ND	ND	ND	ND
Vanadium	ND	0.0074 (B)	0.0303 (B)	ND	0.014 (B)	ND
Zinc	0.01 (B)	0.0111 (B)	0.0904	0.0201	0.0599	ND
Pesticides - TCL (µg/l)						
4,4'-DDD	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND
Anions (mg/l)						
Chloride	9.9	10	19	18	3	18
Fluoride	0.49	0.64	0.64	0.71	0.38	ND
Nitrate-N	0.021 (J)	0.029 (J)	0.021 (J)	0.016 (J)	ND	0.016 (J)
Sulfate	53	120	49	51	74	400
Total Dissolved Solids (mg/l)	380	320	350	400	490	1300

Table 4: Summary of Detected Constituents in the Lower Zone--Continued

Notes

TCL - Target Compound List

TAL - Target Analyte List

B - Analyte was found in the associated blank as well as the sample

E - Compounds whose concentrations exceed the calibration of the GC/MS instrument for that specific analysis

J - Estimated Value

N - Presumptive evidence of a compound

-- - Did not analyze

µg/l - Micrograms per liter

mg/l - Milligrams per liter

ND - Not detected above practical quantitation limits

P - Greater than 25% difference for detected concentrations between the two GC columns

S - The reported value was determined by the Method of Standard Additions (MSA)

Prepared/Date: SLQ 1/19/96

Checked/Date: DPD 2/5/96

Table 5: Summary of Detected Constituents in Surface Water

Sample Location Sampling Date	L-01-002SW (12/1/95)	L-DUP-009SW (L-01-002SW)	L-02-002SW (12/1/95)
Volatile Organic Compounds - TCL (µg/l)			
1,2-Dichloroethene (Total)	ND	ND	4 (J)
Benzene	ND	ND	ND
Carbon Disulfide	ND	ND	ND
Ethylbenzene	ND	ND	ND
Methylene Chloride	ND	ND	ND
Toluene	0.6 (J)	ND	0.3 (J)
Trichloroethene	ND	ND	1 (J)
Xylene (Total)	ND	ND	ND
Semi-Volatile Organic Compounds - TCL (µg/l)			
2-Methylnaphthalene	ND	ND	ND
Acenaphthene	ND	ND	ND
Anthracene	ND	ND	ND
Benzo(a)Anthracene	ND	ND	ND
Benzo(a)Pyrene	ND	ND	ND
Benzo(b)Fluoranthene	ND	ND	ND
Benzo(g,h,i)Perylene	ND	ND	ND
Benzo(k)Fluoranthene	ND	ND	ND
Bis(2-Ethylhexyl)Phthalate	0.9 (J)	0.8 (J)	2 (J)
Chrysene	ND	ND	ND
Dibenzofuran	ND	ND	ND
Diethylphthalate	ND	ND	ND
Di-N-Butylphthalate	0.2 (J)	ND	ND
Fluoranthene	ND	ND	ND
Fluorene	ND	ND	ND
Indeno(1,2,3-cd)Pyrene	ND	ND	ND
Naphthalene	ND	ND	ND
Phenanthrene	ND	ND	ND
Phenol	ND	ND	ND
Pyrene	ND	ND	ND
Metals - TAL (mg/l)			
Aluminum	0.0656 (B)	0.0667 (B)	1.02
Antimony	ND	ND	ND
Arsenic	ND	0.001 (B)	ND

Table 5: Summary of Detected Constituents in Surface Water--Continued

Sample Location Sampling Date	L-01-002SW (12/1/95)	L-DUP-009SW (L-01-002SW)	L-02-002SW (12/1/95)
Metals - TAL (mg/l)--Continued			
Barium	0.0506 (B)	0.0484 (B)	0.0372 (B)
Beryllium	ND	ND	ND
Cadmium	ND	ND	0.0044 (B)
Calcium	119	119	65.9
Chromium	ND	0.0174	ND
Cobalt	ND	ND	ND
Copper	0.0207 (B)	0.0382	0.014 (B)
Cyanide	ND	ND	ND
Iron	0.254	0.252	1.49
Lead	ND	ND	0.0021 (B)
Magnesium	53.2	52.6	27.4
Manganese	0.214	0.212	0.0626
Mercury	ND	ND	ND
Nickel	ND	ND	ND
Potassium	3.11 (B)	3.08 (B)	3.96 (B)
Selenium	ND	ND	ND
Silver	ND	ND	ND
Sodium	11.4	11.2	22.2
Thallium	ND	ND	ND
Vanadium	ND	ND	ND
Zinc	ND	ND	0.0852
Pesticides - TCL (µg/l)			
4,4'-DDD	ND	ND	ND
Endrin	ND	ND	ND
Endrin Ketone	ND	ND	ND
Methoxychlor	ND	ND	ND
Anions (mg/l)			
Chloride	--	--	--
Fluoride	--	--	--
Nitrate-N	--	--	--
Sulfate	--	--	--
Total Dissolved Solids (mg/l)	--	--	--

Table 5: Summary of Detected Constituents in Surface Water—Continued

Notes

TCL - Target Compound List

TAL - Target Analyte List

B - Analyte was found in the associated blank as well as the sample

E - Compounds whose concentrations exceed the calibration of the GC/MS instrument for that specific analysis

J - Estimated Value

N - Presumptive evidence of a compound

-- - Did not analyze

µg/l - Micrograms per liter

mg/l - Milligrams per liter

ND - Not detected above practical quantitation limits

P - Greater than 25% difference for detected concentrations between the two GC columns

S - The reported value was determined by the Method of Standard Additions (MSA)

Prepared/Date: SLQ 1/19/96

Checked/Date: DPD 2/5/96

APPENDIX B

EXPOSURE POINT CONCENTRATIONS (EPCS)

Table B-1
Statistical Analysis and Exposure Point Concentrations
Soil
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Minimum Concentration	Average Concentration	Number of Samples	Number of Non-Detects	Detection Frequency	lnUCL	EPC
Cadmium	mg/kg	7	<1.6	3.1	18	1	94	4.3	4.3
Aroclor 1254	µg/kg	140	<33	23	18	17	6	NA	140 ^(a)

Analytes included in this table are those that were chemicals of potential concern for human health receptors.

EPC Exposure point concentration; minimum of the maximum detected concentration and the lnUCL

lnUCL Upper confidence limit on the mean, based on an assumed lognormal distribution

NA Not applicable; insufficient samples to estimate an UCL

(a) The maximum detected concentration was used as the EPC

Table B-2
Statistical Analysis and Exposure Point Concentrations
Sediment
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Minimum Concentration	Average Concentration	Number of Samples	Number of Non-Detects	Detection Frequency	InUCL	EPC (a)
Benzo(a)anthracene	µg/kg	1600	570	1085	2	0	100	NA	1600
Benzo(a)pyrene	µg/kg	2000	590	1295	2	0	100	NA	2000
Benzo(b)fluoranthene	µg/kg	3200	850	2025	2	0	100	NA	3200
Benzo(k)fluoranthene	µg/kg	1000	250	625	2	0	100	NA	1000
Chrysene	µg/kg	2400	690	1545	2	0	100	NA	2400
Dibenz(a,h)anthracene	µg/kg	330	59	194.5	2	0	100	NA	330
Indeno(1,2,3-cd)pyrene	µg/kg	1700	420	1060	2	0	100	NA	1700

Analytes included in this table are those that were chemicals of potential concern for human health receptors.

EPC Exposure point concentration; minimum of the maximum detected concentration and the InUCL

InUCL Upper confidence limit on the mean

NA Not applicable; insufficient samples to estimate an UCL

(a) The maximum detected concentration was used as the EPC

Table B-3
Statistical Analysis and Exposure Point Concentrations
Groundwater
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Minimum Concentration	Average Concentration	Number of Samples	Number of Non-Detects	Detection Frequency	lnUCL	EPC (a)
Arsenic	mg/L	0.0129	<0.01	0.0046	22	4	82	4.2	0.0129
Manganese	mg/L	1.89	0.57	0.57	22	0	100	1.876	1.876 (b)
Benzene	µg/L	9	<10	NA	22	21	5	NA	9
Ethylbenzene	µg/L	5	<10	NA	22	21	5	NA	5
Methylene Chloride	µg/L	7	<10	4.2	22	14	36	4.16	4.16 (b)
Benzo(a)anthracene	µg/L	15	<10	NA	22	21	5	NA	15
Benzo(a)pyrene	µg/L	9	<10	NA	22	21	5	NA	9
Benzo(b)fluoranthene	µg/L	15	<10	NA	22	21	5	NA	15
Benzo(k)fluoranthene	µg/L	4	<10	NA	22	21	5	NA	4
Chrysene	µg/L	15	<10	NA	22	21	5	NA	15
Dibenzofuran	µg/L	41	<10	NA	22	21	5	NA	41
Indeno(1,2,3-cd)pyrene	µg/L	1	<10	NA	22	21	5	NA	1
Naphthalene	µg/L	120	<10	NA	22	21	5	NA	120

Analytes included in this table are those that were chemicals of potential concern for human health receptors.

EPC Exposure point concentration

lnUCL Upper confidence limit on the mean, based on an assumed lognormal distribution

NA Not applicable; insufficient samples to estimate an UCL or an average value

(a) The maximum detected concentration was used as the EPC, unless otherwise indicated

(b) EPC is the minimum of the maximum detected concentration and the lnUCL

Table B-4
Statistical Analysis and Exposure Point Concentrations
Surface Water
Landfill 1, O'Hare ARS

Analyte Name	Units	Maximum Concentration	Minimum Concentration	Average Concentration	Number of Samples	Number of Non-Detects	Detection Frequency	lnUCL	EPC (a)
Arsenic	mg/L	0.001	<0.01	NA	2	1	50	NA	0.001
Trichloroethene	µg/L	1	<10	NA	2	1	50	NA	1

Analytes included in this table are those that were chemicals of potential concern for human health receptors.

EPC Exposure point concentration

lnUCL Upper confidence limit on the mean, based on an assumed lognormal distribution

NA Not applicable; insufficient samples to estimate an UCL or an average value

(a) The maximum detected concentration was used as the EPC.

Table B-5
Air Exposure Point Concentration of Groundwater Contaminants
Human Health Risk Assessment
Landfill 1, O'Hare ARS

COPC	EPC_{liquid} (g/L)	Di,w (cm²/sec)	Do (cm²/sec)	(Kv⁰)_{ponds} (hr⁻¹)	(Kv^c)_{ponds} (hr⁻¹)	KL (cm/hour)	E (g/sec)	EPC_{air} (g/m³)
Benzene	9E-06	9.80E-06	2.20E-05	8.00E-03	3.56E-03	1.78E-01	1.78182E-08	9.68E-12
Methylene chloride	4.36E-06	1.17E-05	2.20E-05	8.00E-03	4.25E-03	2.13E-01	1.03055E-08	5.60E-12
Ethylbenzene	5E-06	7.80E-06	2.20E-05	8.00E-03	2.84E-03	1.42E-01	7.87879E-09	4.28E-12

Parameters of Pond Model	
Length (cm)	200
Width (cm)	200
Depth (cm)	50
Area (cm ²)	40000
CF1 (L/cm ³)	1000
CF2 (hour/sec)	3600
H (Mixing Height of Man, m)	2
Average wind speed (m/s)*	4.6

* Data Source: National Climate Data Center (NCDC), 2003
(<http://www.ncdc.noaa.gov/ol/climate/online/ccd/avgwind.html>)

See Detailed Information in Appendix C.

APPENDIX C

AIR CONCENTRATION MODEL FOR GROUNDWATER VOLATILE COPCS

APPENDIX C

Air Concentration Model for Groundwater Volatile COPCs

Calculations of air concentrations are based on the assumption that during construction work, soil is excavated and groundwater is exposed to the air. The exposed area is modeled as a shallow pond with dimensions of 2 m x 2 m x 0.5 m. EPC_{air} is calculated using a “box model” approach, described in U.S. EPA (1986), by using the following equation,

$$EPC_{air} = \frac{E}{W \times U \times H} \quad (1)$$

where:

H = Mixing height = 2 m (height of an average man)

U = Average wind speed within mixing zone = 4.6 m/s (NCDC, 2003)

W = Width dimension of the pond = 2 m

E = Emission rate (g/s)

The emission rate is determined by using the following equations (Thomas, 1990):

$$E = K_l \times C \times A \quad (2)$$

where:

K_l = Liquid phase mass transfer coefficient (cm/s)

C = Concentration of chemical in liquid phase (g/cm³)

A = Contaminated area (cm²) = 200 x 200 (cm²)

K_l is calculated from:

$$(K_v^c)_{env} = \frac{K_l}{Z} \quad (3)$$

where:

$(K_v^c)_{env}$ = Overall liquid phase exchange coefficient (hour⁻¹)

Z = Depth of the pond (cm) = 50 cm

$(K_v^c)_{env}$ for ponds is estimated by the equation:

$$(K_v^c)_{env} = \frac{D^c}{D^o} (K_v^o)_{Ponds} \quad (4)$$

where:

D^c = Diffusion coefficient of the chemical in water (cm^2/sec)

D^o = Diffusion coefficient of oxygen in water (cm^2/sec) $= 2.20 \times 10^{-5} \text{ cm}^2/\text{sec}$
(Thomas, 1990 and EPA 1996)

$(K_v^o)_{Ponds}$ = Oxygen reaeration coefficient (hour^{-1}) = 0.008

References:

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APPENDIX D

HUMAN HEALTH RISK ASSESSMENT CALCULATIONS

Table D-1
Toxicity Factors for Chemicals of Potential Concern

Carcinogenic Risk									
COPC	Ingestion Slope Factor (kg-day/mg)	EPC for Soil (µg/kg)	EPC for Sediment (µg/kg)	EPC for SW (µg/L)	EPC for GW (µg/L)	EPC for GW (volatile) (g/m³)	Inhalation Slope Factor (kg-day/mg)	Dermal Slope Factor (kg-day/mg)	Volatile (URF)
									Inhalation Risk Factor (m³/µg)
Arsenic	1.50E+00			1	12.9		1.50E+01	1.50E+00	4.30E-03
Cadmium	NA	4300					6.30E+00	NA	1.80E-03
Benzene	5.50E-02				9	9.68E-12	2.73E-02	5.50E-02	7.80E-06
Benzo(a)anthracene	7.30E-01		1600		15		3.10E-01	7.30E-01	8.86E-05
Benzo(a)pyrene	7.30E+00		2000		9		3.10E+00	7.30E+00	8.86E-04
Benzo(b)fluoranthene	7.30E-01		3200		15		3.10E-01	7.30E-01	8.86E-05
Benzo(k)fluoranthene	7.30E-02		1000		4		3.10E-02	7.30E-02	8.86E-06
Chrysene	7.30E-03		2400		15		3.10E-03	7.30E-03	8.86E-07
Dibenz(a,h)anthracene	7.30E+00		330				3.10E+00	7.30E+00	8.86E-04
Indeno(1,2,3-c,d)pyrene	7.30E-01		1700		1		3.10E-01	7.30E-01	8.86E-05
Trichloroethene	4.00E-01			1			4.00E-01	4.00E-01	1.40E-03

Noncarcinogenic Risk									
COPC	Ingestion Reference Dose (mg/kg-day)	EPC for Soil (µg/kg)	EPC for Sediment (µg/kg)	EPC for SW (µg/L)	EPC for GW (µg/L)	EPC for GW (volatile) (g/m³)	Inhalation Reference Dose (mg/kg-day)	Dermal Reference Dose (mg/kg-day)	Volatile Inhalation Ref. Dose
									(mg/m3)
Arsenic	3.00E-04			1	12.9		NA	3.00E-04	NA
Cadmium	5.00E-04	4300					NA	2.50E-05	NA
Manganese	4.60E-02				1876		1.43E-05	1.84E-03	5.00E-05
Benzene	4.00E-03				9	9.68E-12	8.57E-03	4.00E-03	3.00E-02
Ethylbenzene	1.00E-01				5	5.60E-12	2.86E-01	1.00E-01	1.00E+00
Methylene Chloride	NA				4.36	4.28E-12	2.57E-02	NA	9.00E-02
Naphthalene	2.00E-02				120		8.57E-04	2.00E-02	3.00E-03
Trichloroethene	3.00E-04			1			1.14E-02	3.00E-04	4.00E-02
Aroclor 1254	2.00E-05	140					NA	2.00E-05	NA

Table D-2.
Soil Ingestion Exposure Factors

Carcinogenic Risk

$$LADD = EPC \times FI \times IRs \times EF \times ED \times CF / (BW \times ATc)$$

EPC=exposure point concentration (µg/kg)

FI=fraction ingested from contaminated source (unitless)

IRs=soil ingestion rate (mg/day)

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor 10⁻⁹ kg/µg

BW=body weight (kg)

ATc=averaging time for carcinogens (days)

$$ELCR = LADD \times SFO$$

SFO=oral cancer slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
IRs (mg/day)	100	100	100	480	100
FI	0.25	0.5	0.25	1	0.25
EF (day/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
ATc (days)	25550	25550	25550	25550	25550
Conversion Factor (kg/µg)	1.0E-09	1.0E-09	1.0E-09	1.0E-09	1.0E-09

Noncarcinogenic Risk

$$ADD = EPC \times FI \times IRs \times EF \times ED \times CF / (BW \times ATn)$$

EPC=exposure point concentration (µg/kg)

FI=fraction ingested from contaminated source (unitless)

IRs=soil ingestion rate (mg/day)

EF=exposure frequency (days/year)

ED=exposure duration (years)

BW=body weight (kg)

ATn=averaging time for noncarcinogens (days)

$$HQ = ADD / RfDo$$

ADD=average daily dose (mg/kg-day)

RfDo=Ingestion reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
IRs (mg/day)	100	100	100	480	100
FI	0.25	0.5	0.25	1	0.25
EF (day/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
ATn (days)	9125	9125	9125	40	4015
Conversion Factor (kg/µg)	1.00E-09	1.00E-09	1.00E-09	1.00E-09	1.00E-09

Table D-3.
Soil Ingestion Exposure Evaluation

Carcinogenic Risk										
	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	4.51E-09		7.51E-07		7.81E-08		3.46E-08		5.47E-08	

Noncarcinogenic Risk										
	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	1.26E-08	2.52E-05	2.10E-06	4.21E-03	2.19E-07	4.38E-04	2.21E-05	4.42E-02	3.48E-07	6.96E-04
Aroclor 1254	4.11E-10	2.05E-05	6.85E-08	3.42E-03	7.12E-09	3.56E-04	7.20E-07	3.60E-02	1.13E-08	5.67E-04

Summary					
	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
ELCR for this pathway	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HI for this pathway	4.58E-05	7.63E-03	7.94E-04	8.02E-02	1.26E-03

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

Table D-4.
Soil Dermal Exposure Factors

Carcinogenic Risk

$$LADD = EPC \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times ATc)$$

EPC=exposure point concentration (µg/kg)

SA=body surface area (cm²/day)

AF=soil adherence factor (mg/cm²)

ABS=dermal adsorption factor (unitless)

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor (10⁻⁹ kg/µg)

BW=body weight (kg)

ATc=averaging time for carcinogens (days)

$$ELCR = LADD \times SFd$$

SFd=dermal cancer slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ²)	5300	5300	5300	5300	4400
AF (mg/cm ² -day)	0.2	0.2	0.11	0.5	0.11
ABS (unitless)	Chemical Specific				
EF (day/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
Atc (days)	25550	25550	25550	25550	25550
Conversion Factor (kg/µg)	1.00E-09	1.00E-09	1.00E-09	1.00E-09	1.00E-09

Noncarcinogenic Risk

$$ADD = EPC \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times ATn)$$

EPC=exposure point concentration (µg/kg)

SA=body surface area (cm²/day)

AF=soil adherence factor (mg/cm²)

ABS=dermal adsorption factor

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor 10⁻⁹ kg/mg

BW=body weight (kg)

ATn=averaging time for noncarcinogens (days)

$$HQ = ADD / RfDd$$

ADD=average daily dose (mg/kg-day)

RfDd=dermal reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ² /day)	5300	5300	5300	5300	4400
AF (mg/cm ²)	0.2	0.2	0.11	0.5	0.11
ABS (unitless)	Chemical Specific				
EF (day/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
Atn (days)	9125	9125	9125	40	4015
Conversion Factor (kg/µg)	1.00E-09	1.00E-09	1.00E-09	1.00E-09	1.00E-09

**Table D-5.
Soil Dermal Exposure Evaluation**

Carcinogenic Risk											
	Dermal Adsorption Fraction	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC		LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR
Cadmium	1.00E-03	1.91E-10		1.59E-08		1.82E-09		1.91E-10		1.06E-09	

Noncarcinogenic Risk											
	Dermal Adsorption Fraction	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC		ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ
Cadmium	1.00E-03	5.35E-10	2.14E-05	4.46E-08	1.78E-03	5.10E-09	2.04E-04	1.22E-07	4.88E-03	6.74E-09	2.70E-04
Aroclor 1254	1.40E-01	2.44E-09	1.22E-04	2.03E-07	1.02E-02	2.33E-08	1.16E-03	5.57E-07	2.78E-02	3.07E-08	1.54E-03

Summary						
		Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
ELCR for this pathway=		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HI for this pathway=		1.43E-04	1.19E-02	1.37E-03	3.27E-02	1.81E-03

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

Table D-6.
Particulate Inhalation Exposure Factors

Carcinogenic Risk

$$LADD = EPC \times ER \times IR \times EF \times ED / (BW \times AT_c \times PEF)$$

EPC=exposure point concentration of soil (µg/kg)

ER=exposure rate (hours/day)

IR=inhalation rate (m³/hour)

EF=exposure frequency (days/year)

ED=exposure duration (years)

BW=body weight (kg)

AT_c=averaging time for carcinogens (days)

PEF= Particulate Emission factor (m³/kg)

$$ELCR = LADD \times SFi$$

SFi=inhalation cancer slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
IR (m ³ /hour)	2.8	2.8	2.8	2.8	2.8
ER (hours/day)	1	2	2	8	2
EF (days/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
Atc (days)	25550	25550	25550	25550	25550
PEF (m ³ /kg)	1.24E+09	1.24E+09	1.24E+09	1.24E+08	1.24E+09
Conversion Factor (mg/µg)	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03

Noncarcinogenic Risk

$$ADD = EPC \times ER \times IR \times EF \times ED / (BW \times AT_n \times PEF)$$

EPC=exposure point concentration of soil (µg/kg)

ER=exposure rate (hours/day)

IR=inhalation rate (m³/hr)

EF=exposure frequency (days/year)

ED=exposure duration (years)

BW=body weight (kg)

AT_n=averaging time for noncarcinogens (days)

$$HQ = ADD / RfDi$$

ADD=average daily dose (mg/kg-day)

RfDi=inhalation reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
IR (m ³ /hour)	2.8	2.8	2.8	2.8	2.8
ER (hr/day)	1	2	2	8	2
EF (days/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
Atn (days)	9125	9125	9125	40	4015
PEF (m ³ /kg)	1.24E+09	1.24E+09	1.24E+09	1.24E+08	1.24E+09
Conversion Factor (mg/µg)	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03

Table D-7
Particulate Exposure Evaluation

Carcinogenic Risk										
	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR
Cadmium	4.07E-13	2.57E-12	6.79E-11	4.28E-10	1.41E-11	8.89E-11	1.30E-11	8.21E-11	9.88E-12	6.22E-11

Noncarcinogenic Risk										
	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ
Cadmium	1.14E-12		1.90E-10		3.95E-11		8.32E-09		6.29E-11	
Aroclor 1254	3.71E-14		6.19E-12		1.29E-12		2.71E-10		2.05E-12	

Summary										
	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
ELCR for this pathway=	2.57E-12		4.28E-10		8.89E-11		8.21E-11		6.22E-11	
HI for this pathway=	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

**Table D-8.
Sediment Dermal Exposure Factors**

Carcinogenic Risk

$$LADD = EPC \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT_c)$$

EPC=exposure point concentration (µg/kg)

SA=body surface area (cm²/day)

AF=soil adherence factor (mg/cm²)

ABS=dermal adsorption factor (unitless)

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor (10⁻⁹ kg/µg)

BW=body weight (kg)

AT_c=averaging time for carcinogens (days)

$$ELCR = LADD \times SF_d$$

SF_d=dermal cancer slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ²)		3300		3300	
AF (mg/cm ² -day)		0.2		0.5	
ABS (unitless)	Chemical Specific				
EF (days/year)	3	5	5	5	5
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
Atc (days)	25550	25550	25550	25550	25550
Conversion Factor (kg/µg)	1.00E-09	1.00E-09	1.00E-09	1.00E-09	1.00E-09

Noncarcinogenic Risk

$$ADD = EPC \times SA \times AF \times ABS \times EF \times ED \times CF / (BW \times AT_n)$$

EPC=exposure point concentration (µg/kg)

SA=body surface area (cm²/day)

AF=soil adherence factor (mg/cm²)

ABS=dermal adsorption factor

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor 10⁻⁹ kg/mg

BW=body weight (kg)

AT_n=averaging time for noncarcinogens (days)

$$HQ = ADD / RfD_o$$

ADD=average daily dose (mg/kg-day)

RfD_d=dermal reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ² /day)	0	3300	0	3300	0
AF (mg/cm ²)	0	0.2	0	0.5	0
ABS	Chemical Specific				
EF (day/year)	3	250	52	30	52
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	44
Atn (days)	9125	9125	9125	40	4015
Conversion Factor kg/µg)	1.00E-09	1.00E-09	1.00E-09	1.00E-09	1.00E-09

Table D-9.
Sediment Dermal Exposure Evaluation

Carcinogenic Risk											
	Dermal Adsorption Fraction	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC		LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR
Arsenic	3.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	1.00E-03	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	1.30E-01	0.00E+00	0.00E+00	9.59E-09	7.00E-09	0.00E+00	0.00E+00	9.59E-10	7.00E-10	0.00E+00	0.00E+00
Benzo(a)pyrene	1.30E-01	0.00E+00	0.00E+00	1.20E-08	8.76E-08	0.00E+00	0.00E+00	1.20E-09	8.76E-09	0.00E+00	0.00E+00
Benzo(b)fluoranthene	1.30E-01	0.00E+00	0.00E+00	1.92E-08	1.40E-08	0.00E+00	0.00E+00	1.92E-09	1.40E-09	0.00E+00	0.00E+00
Benzo(k)fluoranthene	1.30E-01	0.00E+00	0.00E+00	6.00E-09	4.38E-10	0.00E+00	0.00E+00	6.00E-10	4.38E-11	0.00E+00	0.00E+00
Chrysene	1.30E-01	0.00E+00	0.00E+00	1.44E-08	1.05E-10	0.00E+00	0.00E+00	1.44E-09	1.05E-11	0.00E+00	0.00E+00
Dibenz(a,h)anthracene	1.30E-01	0.00E+00	0.00E+00	1.98E-09	1.44E-08	0.00E+00	0.00E+00	1.98E-10	1.44E-09	0.00E+00	0.00E+00
Indeno(1,2,3-c,d)pyrene	1.30E-01	0.00E+00	0.00E+00	1.02E-08	7.44E-09	0.00E+00	0.00E+00	1.02E-09	7.44E-10	0.00E+00	0.00E+00

Noncarcinogenic Risk											
	Dermal Adsorption Fraction	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC		ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ
Arsenic	3.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	1.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ethylbenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene Chloride	0.00E+00	0.00E+00		0.00E+00		0.00E+00		0.00E+00		0.00E+00	
Naphthalene	1.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254	1.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Summary						
		Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
ELCR for this pathway=		0.00E+00	1.31E-07	0.00E+00	1.31E-08	0.00E+00
HI for this pathway=		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

Table D-10.
Surface Water Dermal Exposure Factors

Carcinogenic Risk

$$LADD = EPC \times SA \times PC \times ET \times EF \times ED \times CF / (BW \times AT_c)$$

EPC=exposure point concentration (µg/L)

SA=skin surface area (cm²)

PC=permeability constant (cm/hr)

EF=exposure frequency (days/year)

ET=exposure time (hour/day)

ED=exposure duration (years)

CF=conversion factor 10⁻⁶ (L-mg/cm³-µg)

BW=body weight (kg)

Atc=averaging time for carcinogens (days)

$$ELCR = LADD \times SF_d$$

SF_d=dermal cancer slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ²)		3300		3300	
PC (cm/hr)	Chemical Specific				
EF (day/year)		5		5	
ET (hour/day)	1	1	1	1	1
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	40
Atc (days)	25550	25550	25550	25550	25550
Conversion Factor (L-mg/cm ³ -µg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06

Noncarcinogenic Risk

$$ADD = EPC \times SA \times PC \times ET \times EF \times ED \times CF / (BW \times AT_n)$$

EPC=exposure point concentration (µg/L)

SA=skin surface area (cm²)

PC=permeability constant (cm/hr)

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor 10⁻⁶ (L-mg/cm³-µg)

CF=conversion factor 10⁻⁶ (L-mg/cm³-µg)

BW=body weight (kg)

AT_n=averaging time for noncarcinogens (days)

$$HQ = ADD / RfD_o$$

ADD=average daily dose (mg/kg-day)

RfD_d=dermal reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ²)		3300		3300	
PC (cm/hr)	Chemical Specific				
EF (day/year)	3	250	52	30	52
ET (hour/day)	1	1	1	1	1
ED (years)	25	25	25	1	11
BW (kg)	70	70	70	70	40
Atn (days)	9125	9125	9125	40	4015
Conversion Factor (L-mg/cm ³ -µg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06

Table D-11.
Surface Water Dermal Exposure Evaluation

Carcinogenic Risk											
	Permeability Constant	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC		LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR	LADD	ELCR
Arsenic	1.00E-03	0.00E+00	0.00E+00	2.31E-10	3.46E-10	0.00E+00	0.00E+00	9.23E-12	1.38E-11	0.00E+00	0.00E+00
Trichloroethene	1.20E-02	0.00E+00	0.00E+00	2.77E-09	1.11E-09	0.00E+00	0.00E+00	1.11E-10	4.43E-11	0.00E+00	0.00E+00

Noncarcinogenic Risk											
	Permeability Constant	Mower		Maintenance Worker		On-site Worker		Construction Worker		Trespasser	
COPC		ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ	ADD	HQ
Arsenic	1.00E-03	0.00E+00	0.00E+00	3.23E-08	1.08E-04	0.00E+00	0.00E+00	3.54E-08	1.18E-04	0.00E+00	0.00E+00
Trichloroethene	1.20E-02	0.00E+00	0.00E+00	3.87E-07	1.29E-03	0.00E+00	0.00E+00	4.24E-07	1.41E-03	0.00E+00	0.00E+00

Summary						
		Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
ELCR for this pathway=		0.00E+00	1.45E-09	0.00E+00	5.81E-11	0.00E+00
HI for this pathway=		0.00E+00	1.40E-03	0.00E+00	1.53E-03	0.00E+00

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

Table D-12.
Groundwater Dermal Exposure Factors

Carcinogenic Risk

$$LADD = EPC \times SA \times PC \times ET \times EF \times ED \times CF / (BW \times ATc)$$

EPC=exposure point concentration (µg/L)

SA=skin surface area (cm²)

PC=permeability constant (cm/hr)

EF=exposure frequency (days/year)

ET=exposure time (hour/day)

ED=exposure duration (years)

CF=conversion factor 10⁻⁶ (L-mg/cm³-µg)

BW=body weight (kg)

Atc=averaging time for carcinogens (days)

$$ELCR = LADD \times SFd$$

SFd=dermal cancer slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ²)				3300	
PC (cm/hr)	Chemical Specific				
EF (days/year)				5	
ET (hours/day)				1	
ED (years)				1	
BW (kg)	70	70	70	70	44
Atc (days)	25550	25550	25550	25550	25550
Conversion Factor (L-mg/cm ³ -µg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06

Noncarcinogenic Risk

$$ADD = EPC \times SA \times PC \times ET \times EF \times ED \times CF / (BW \times ATn)$$

EPC=exposure point concentration (µg/L)

SA=skin surface area (cm²)

PC=permeability constant (cm/hr)

EF=exposure frequency (days/year)

ED=exposure duration (years)

CF=conversion factor 10⁻⁶ (L-mg/cm³-µg)

CF=conversion factor 10⁻⁶ (L-mg/cm³-µg)

BW=body weight (kg)

ATn=averaging time for noncarcinogens (days)

$$HQ = ADD / RfDd$$

ADD=average daily dose (mg/kg-day)

RfDd=dermal reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
SA (cm ²)				3300	
PC (cm/hr)	Chemical Specific				
EF (days/year)				5	
ET (hours/day)				1	
ED (years)				1	
BW (kg)	70	70	70	70	44
Atn (days)	9125	9125	9125	40	4015
Conversion Factor (L-mg/cm ³ -µg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06

Table D-13.
Groundwater Dermal Exposure Evaluation

Carcinogenic Risk			
	Permeability Constant	Construction Worker	
COPC		LADD	ELCR
Arsenic	1.00E-03	1.19E-10	1.79E-10
Benzene	1.50E-02	1.25E-09	6.85E-11
Benzo(a)anthracene	4.70E-01	6.50E-08	4.75E-08
Benzo(a)pyrene	7.00E-01	5.81E-08	4.24E-07
Benzo(b)fluoranthene	7.00E-01	9.69E-08	7.07E-08
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00
Chrysene	4.70E-01	6.50E-08	4.75E-10
Dibenz(a,h)anthracene	1.50E+00	0.00E+00	0.00E+00
Indeno(1,2,3-c,d)pyrene	1.00E+00	9.23E-09	6.73E-09

Noncarcinogenic Risk			
	Permeability Constant	Construction Worker	
COPC		ADD	HQ
Arsenic	1.00E-03	7.60E-08	2.53E-04
Cadmium	1.00E-03	0.00E+00	0.00E+00
Manganese	1.00E-03	1.11E-05	6.01E-03
Benzene	1.50E-02	7.96E-07	1.99E-04
Ethylbenzene	4.90E-02	1.44E-06	1.44E-05
Methylene Chloride	3.50E-03	8.99E-08	
Naphthalene	4.70E-02	3.32E-05	1.66E-03

Summary		
		Construction Worker
ELCR for this pathway=		5.50E-07
HI for this pathway=		8.14E-03

Notes:
 ELCR: Excess lifetime cancer risks
 HI: Hazard index
 COPC: Contaminants of potential concern
 LADD: Lifetime average daily dose
 ADD: Average daily dose
 HQ: Hazard quotient

Table D-13.
Groundwater Dermal Exposure Evaluation

Carcinogenic Risk			
	Permeability Constant	Construction Worker	
COPC		LADD	ELCR
Arsenic	1.00E-03	1.19E-10	1.79E-10
Benzene	1.50E-02	1.25E-09	6.85E-11
Benzo(a)anthracene	4.70E-01	6.50E-08	4.75E-08
Benzo(a)pyrene	7.00E-01	5.81E-08	4.24E-07
Benzo(b)fluoranthene	7.00E-01	9.69E-08	7.07E-08
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00
Chrysene	4.70E-01	6.50E-08	4.75E-10
Indeno(1,2,3-c,d)pyrene	1.00E+00	9.23E-09	6.73E-09

Noncarcinogenic Risk			
	Permeability Constant	Construction Worker	
COPC		ADD	HQ
Arsenic	1.00E-03	7.60E-08	2.53E-04
Manganese	1.00E-03	1.11E-05	6.01E-03
Benzene	1.50E-02	7.96E-07	1.99E-04
Ethylbenzene	4.90E-02	1.44E-06	1.44E-05
Methylene Chloride	3.50E-03	8.99E-08	
Naphthalene	4.70E-02	3.32E-05	1.66E-03

Summary		
		Construction Worker
ELCR for this pathway=		5.50E-07
HI for this pathway=		8.14E-03

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

Table D-14.
Groundwater Volatile Inhalation Exposure Factors

Carcinogenic Risk

$$LADD = (EPC_{air} \times IR \times EF \times ED) / (BW \times AT_c \times CF)$$

EPC_{air}=exposure point concentration in air (g/m³)

IR=inhalation rate (m³/day)

EF=exposure frequency (days/year)

ED=exposure duration (years)

BW=body weight (kg)

AT_c=averaging time for carcinogens (days)

CF=conversion factor

$$ELCR = LADD \times SFi$$

SFi=inhalation slope factor (kg-day/mg)

LADD=lifetime average daily dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
ED (years)				1	
EF(days/year)				30	
AT _c (days)	25550	25550	25550	25550	25550
IR (m ³ /day)	20	20	20	20	20
BW (kg)	70	70	70	70	44
CF(mg-g)	0.001	0.001	0.001	0.001	0.001

Noncarcinogenic Risk

$$ADD = EPC_{air} \times IR \times EF \times ED / (BW \times AT_n \times CF)$$

EPC_{air}=exposure point concentration in air (g/m³)

IR=inhalation rate (m³/day)

EF=exposure frequency (days/year)

ED=exposure duration (years)

AT_n=average time for noncarcinogens (years)

CF=conversion factor

$$HQ = ADD / Rfd$$

ADD=average daily dose

Rfd=volatile inhalation reference dose (mg/kg-day)

Exposure Factor	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
ED (years)				1	
EF(days/year)				30	
AT _n (days)	9125	9125	9125	40	4015
IR (m ³ /day)	20	20	20	20	20
BW (kg)	70	70	70	70	44
CF	0.001	0.001	0.001	0.001	0.001

Table D-15.
Groundwater Volatile Inhalation Exposure Evaluation

Carcinogenic Risk				
	Maintenance Worker		Construction Worker	
COPC	LADD	ELCR	LADD	ELCR
Benzene	0.00E+00	0.00E+00	3.25E-12	8.87E-14

Noncarcinogenic Risk				
	Maintenance Worker		Construction Worker	
COPC	ADD	HQ	ADD	HQ
Benzene	0.00E+00	0.00E+00	2.08E-09	2.42E-07
Ethylbenzene	0.00E+00	0.00E+00	1.20E-09	4.20E-09
Methylene chloride	0.00E+00	0.00E+00	9.18E-10	3.57E-08

Summary		
	Maintenance Worker	Construction Worker
ELCR for this pathway=	0.00E+00	8.87E-14
HI for this pathway=	0.00E+00	2.82E-07

Notes:

ELCR: Excess lifetime cancer risks

HI: Hazard index

COPC: Contaminants of potential concern

LADD: Lifetime average daily dose

ADD: Average daily dose

HQ: Hazard quotient

Table D-16.
Summary of Human Health Risk Assessment

Summary of Human Risk Assessment for Soil, Sediment, Surface Water and Groundwater

	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
Total ELCR	3.E-12	1.E-07	9.E-11	6.E-07	6.E-11
Total HI	2.E-04	2.E-02	2.E-03	1.E-01	1.E-02

Summary of Human Risk Assessment for Soil

	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
Total ELCR	3.E-12	4.E-10	9.E-11	8.E-11	6.E-11
Total HI	2.E-04	2.E-02	2.E-03	1.E-01	3.E-03

Summary of Human Risk Assessment for Groundwater

	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
Total ELCR	0.E+00	0.E+00	0.E+00	5.E-07	0.E+00
Total HI	0.E+00	0.E+00	0.E+00	8.E-03	0.E+00

Summary of Human Risk Assessment for Surface Water

	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
Total ELCR	0.E+00	1.E-09	0.E+00	6.E-11	0.E+00
Total HI	0.E+00	1.E-03	0.E+00	2.E-03	0.E+00

Summary of Human Risk Assessment for Sediment

	Mower	Maintenance Worker	On-site Worker	Construction Worker	Trespasser
Total ELCR	0.E+00	1.E-07	0.E+00	1.E-08	0.E+00
Total HI	0.E+00	0.E+00	0.E+00	0.E+00	0.E+00